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(54) **REMOTE SOFTWARE USAGE  
MONITORING AND ENTITLEMENT  
ANALYSIS**

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(2013.01)

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(56) **References Cited**

U.S. PATENT DOCUMENTS

6,321,229 B1 11/2001 Goldman  
6,609,122 B1 8/2003 Ensor  
7,020,706 B2 3/2006 Cates  
7,028,301 B2 4/2006 Ding  
7,062,683 B2 6/2006 Warpenburg  
7,131,037 B1 10/2006 LeFaive  
7,170,864 B2 1/2007 Matharu

(Continued)

OTHER PUBLICATIONS

“Consuming OpenLM API v4 in your Dashboard”, OpenLM Docs,  
36 pages.

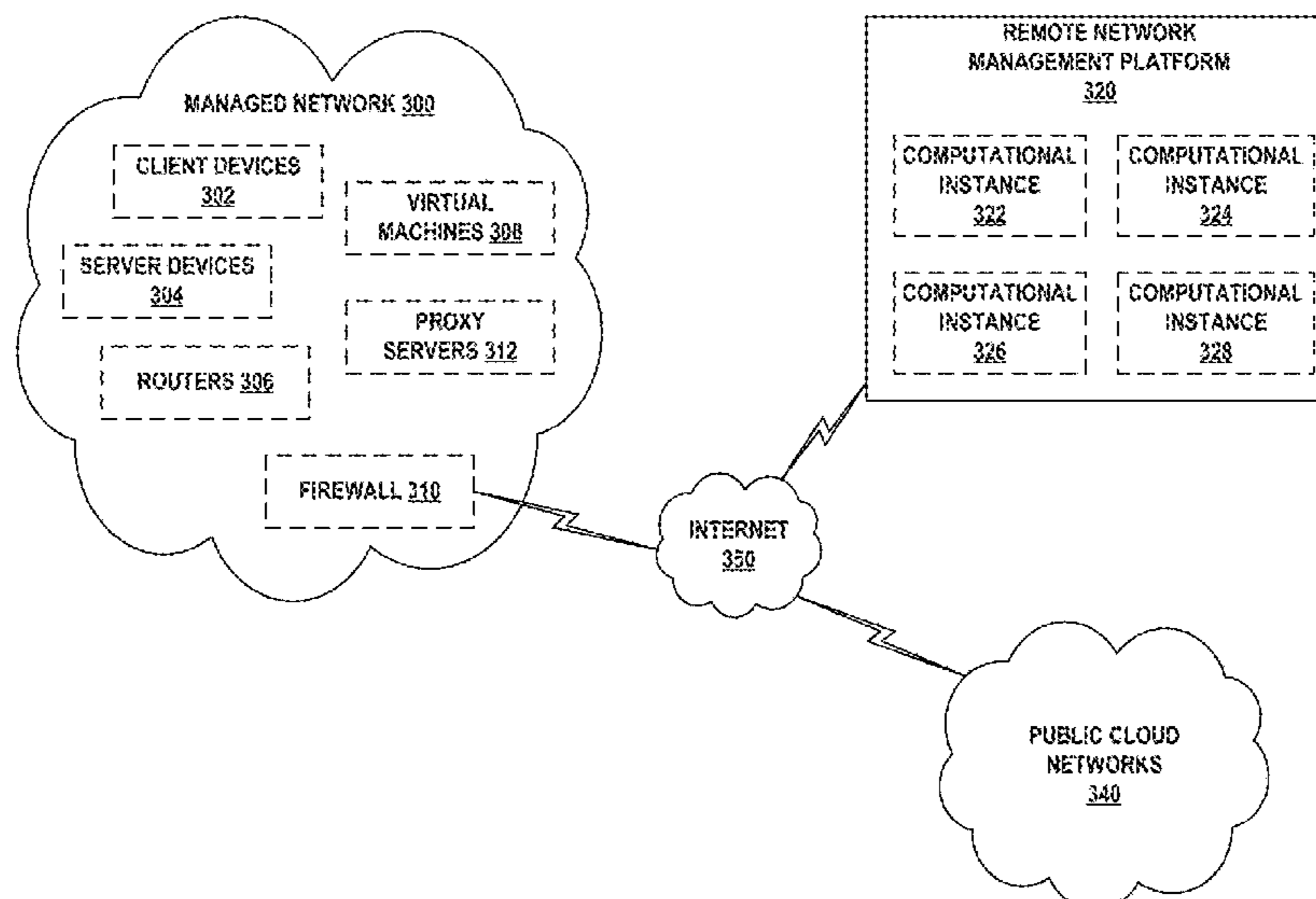
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(57) **ABSTRACT**

A computational instance of a remote network management platform may execute a remote access call for a license consolidation server. The remote access call may contain instructions for obtaining concurrent license usage statistics from the license consolidation server. In response to obtaining the concurrent license usage statistics, the computational instance may update a software configuration with the concurrent license usage statistics, where the software configuration contains a license rights allocation for the concurrent software application. Based on the concurrent license usage statistics and the license rights allocations, the computational instance may generate a representation of a graphical user interface that contains an overview pane indicating a utilization of the concurrent software application. Then the computational instance may transmit, to a client device, the representation of the graphical user interface.

**20 Claims, 13 Drawing Sheets**



(56)

References Cited

U.S. PATENT DOCUMENTS

7,350,209 B2	3/2008	Shum	8,612,408 B2	12/2013	Trinon
7,610,512 B2	10/2009	Gerber	8,646,093 B2	2/2014	Myers
7,617,073 B2	11/2009	Trinon	8,674,992 B2	3/2014	Poston
7,689,628 B2	3/2010	Garg	8,689,241 B2	4/2014	Naik
7,707,115 B2 *	4/2010	Goringe ..... G06Q 10/10 705/59	8,743,121 B2	6/2014	De Peuter
7,716,353 B2	5/2010	Golovinsky	8,832,652 B2	9/2014	Mueller
7,769,718 B2	8/2010	Murley	8,887,133 B2	11/2014	Behnia
7,783,744 B2	8/2010	Garg	9,065,783 B2	6/2015	Ding
7,890,802 B2	2/2011	Gerber	9,098,322 B2	8/2015	Apte
7,925,981 B2	4/2011	Pourheidari	9,122,552 B2	9/2015	Whitney
7,930,396 B2	4/2011	Trinon	9,239,857 B2	1/2016	Trinon
7,945,860 B2	5/2011	Vambenepe	9,317,327 B2	4/2016	Apte
7,966,398 B2	6/2011	Wiles	9,363,252 B2	6/2016	Meuller
8,051,164 B2	11/2011	Peuter	9,535,737 B2	1/2017	Joy
8,151,261 B2	4/2012	Sirota	9,557,969 B2	1/2017	Sharma
8,224,683 B2	7/2012	Manos	9,645,833 B2	5/2017	Mueller
8,266,096 B2	9/2012	Navarrete	9,654,473 B2	5/2017	Miller
8,402,127 B2	3/2013	Solin	9,766,935 B2	9/2017	Kelkar
8,457,928 B2	6/2013	Dang	9,792,387 B2	10/2017	George
8,478,569 B2	7/2013	Scarpelli	9,805,322 B2	10/2017	Kelkar
			2011/0247077 A1 *	10/2011	Nguyen ..... G07F 17/16 726/26
			2017/0161470 A1 *	6/2017	Feng ..... G06F 21/105

\* cited by examiner

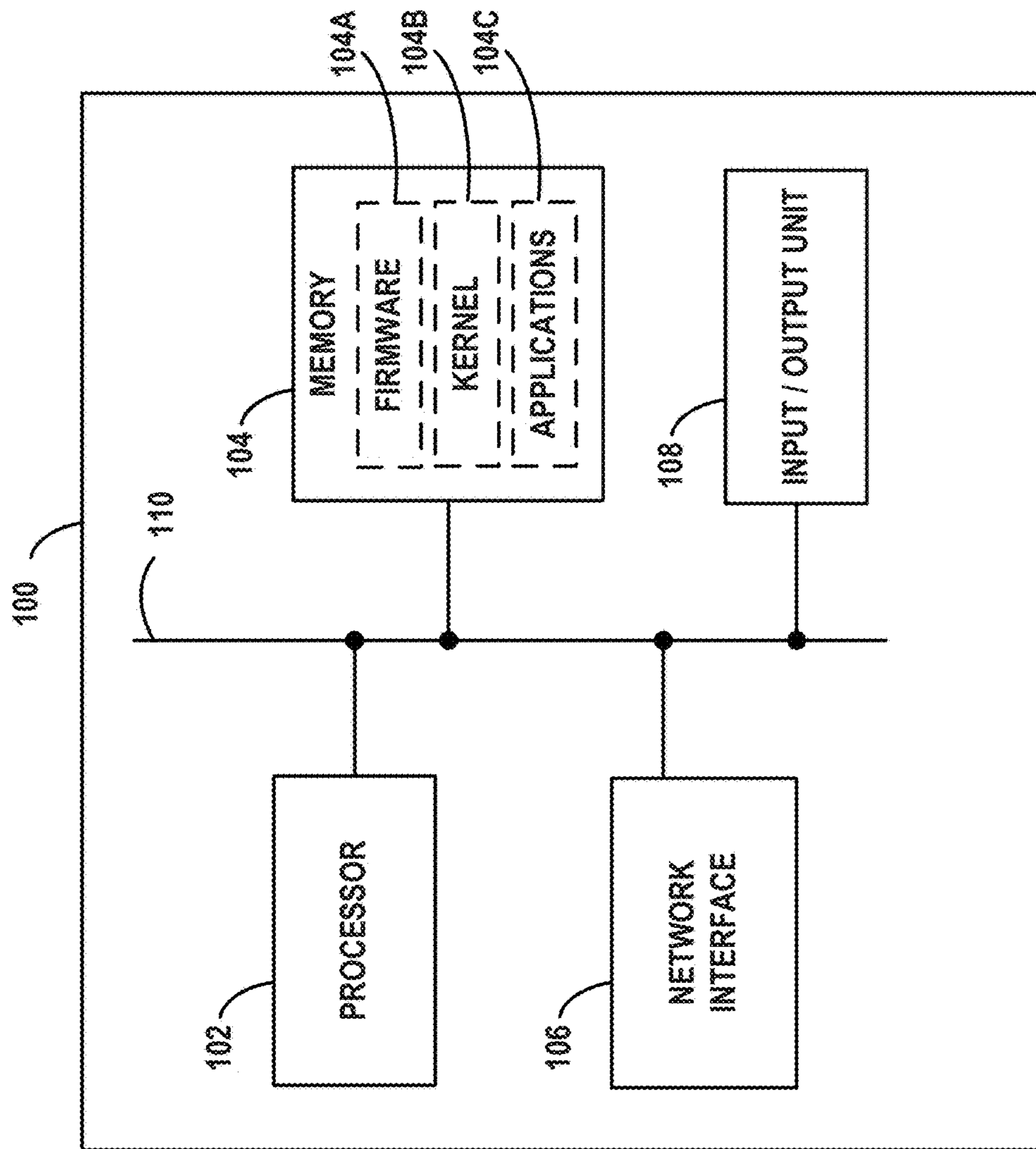
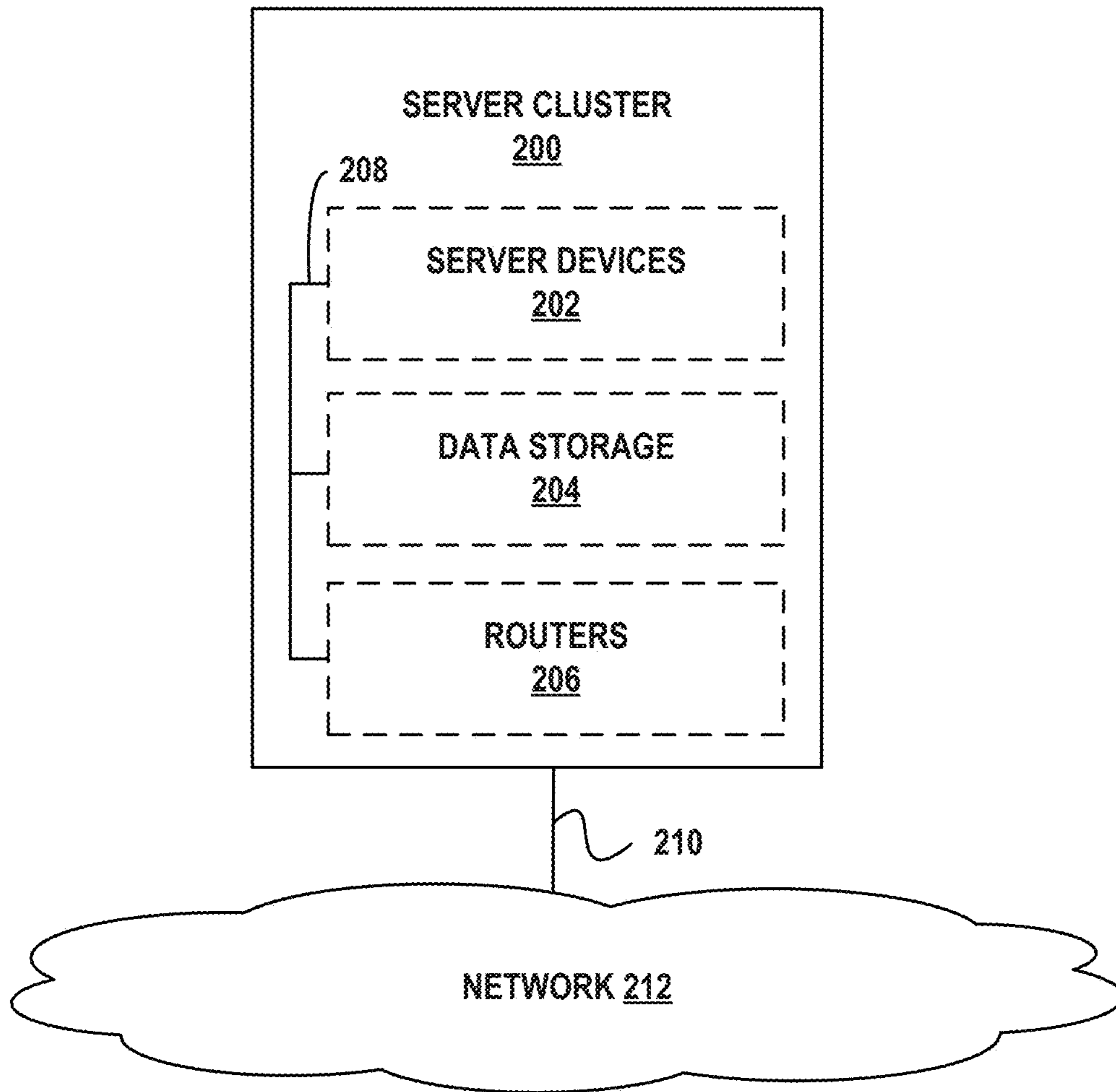


FIG. 1



**FIG. 2**

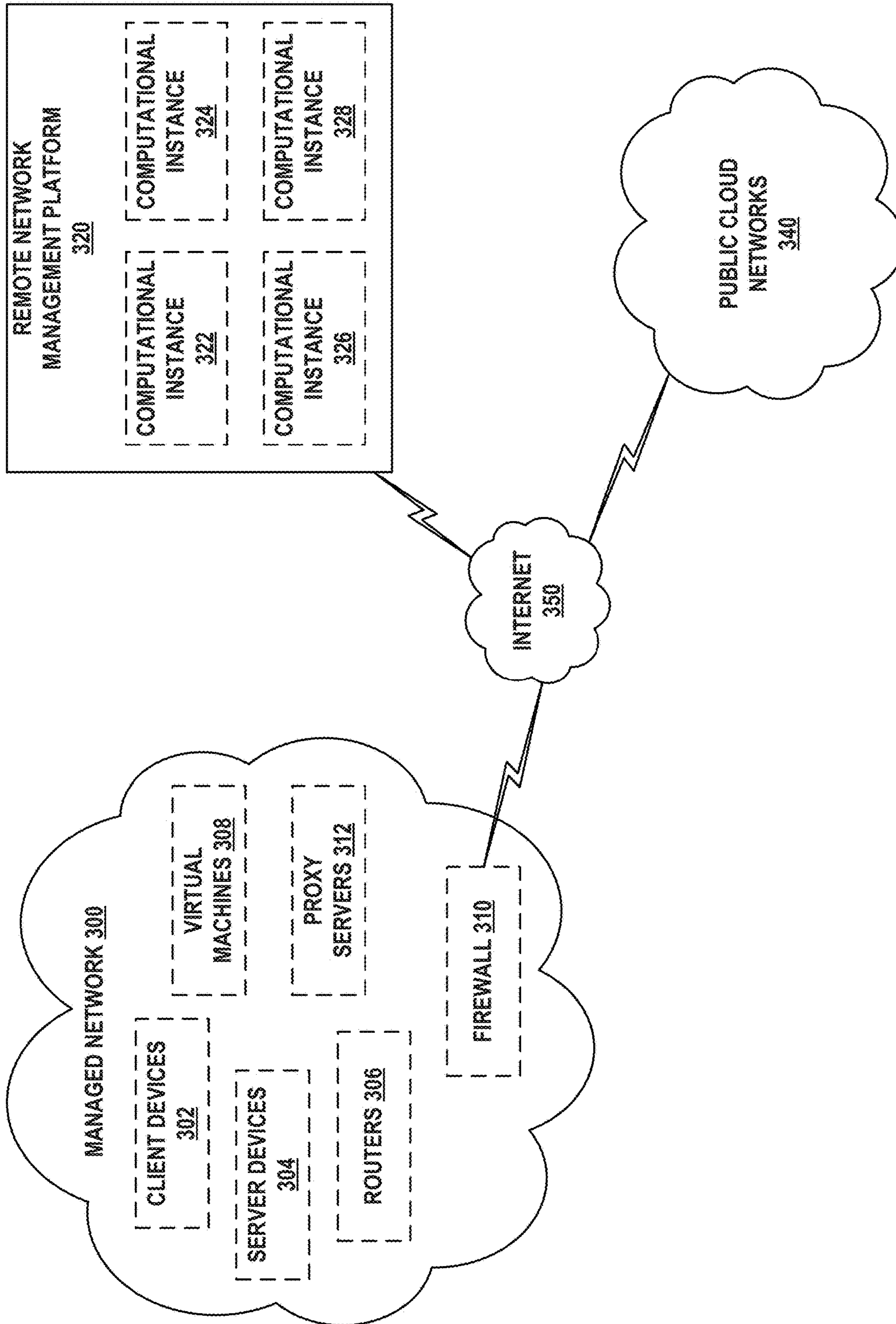


FIG. 3

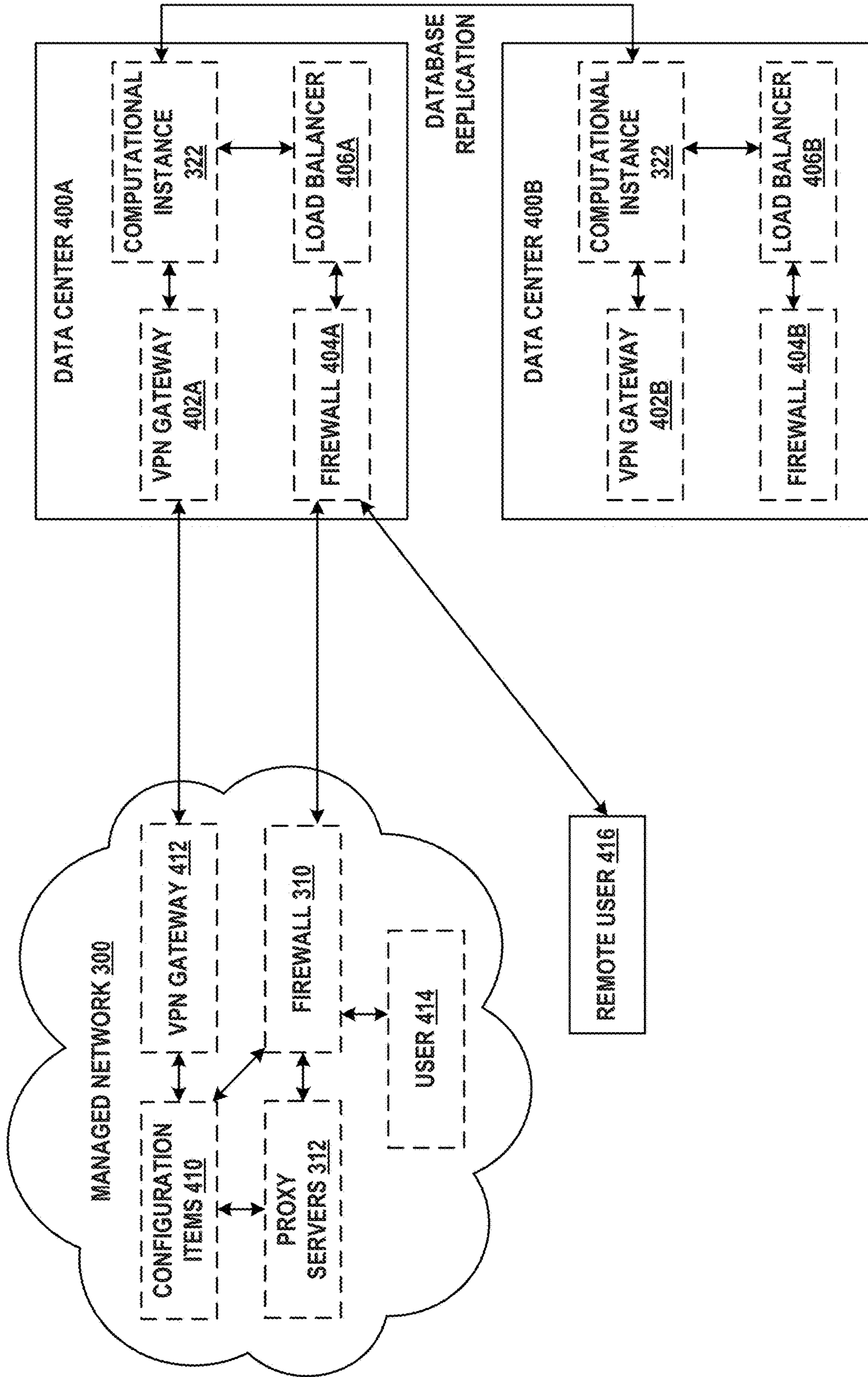


FIG. 4

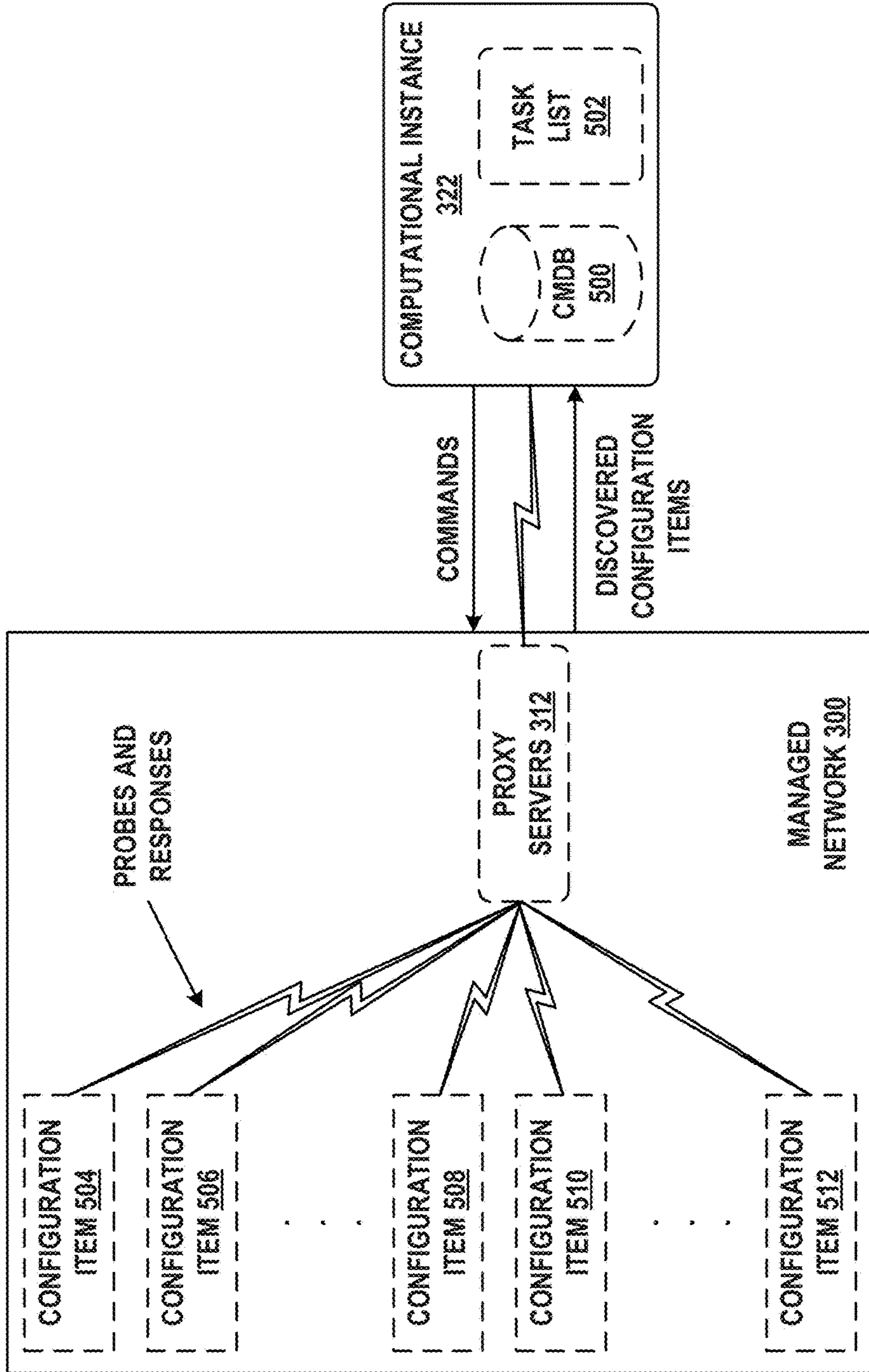
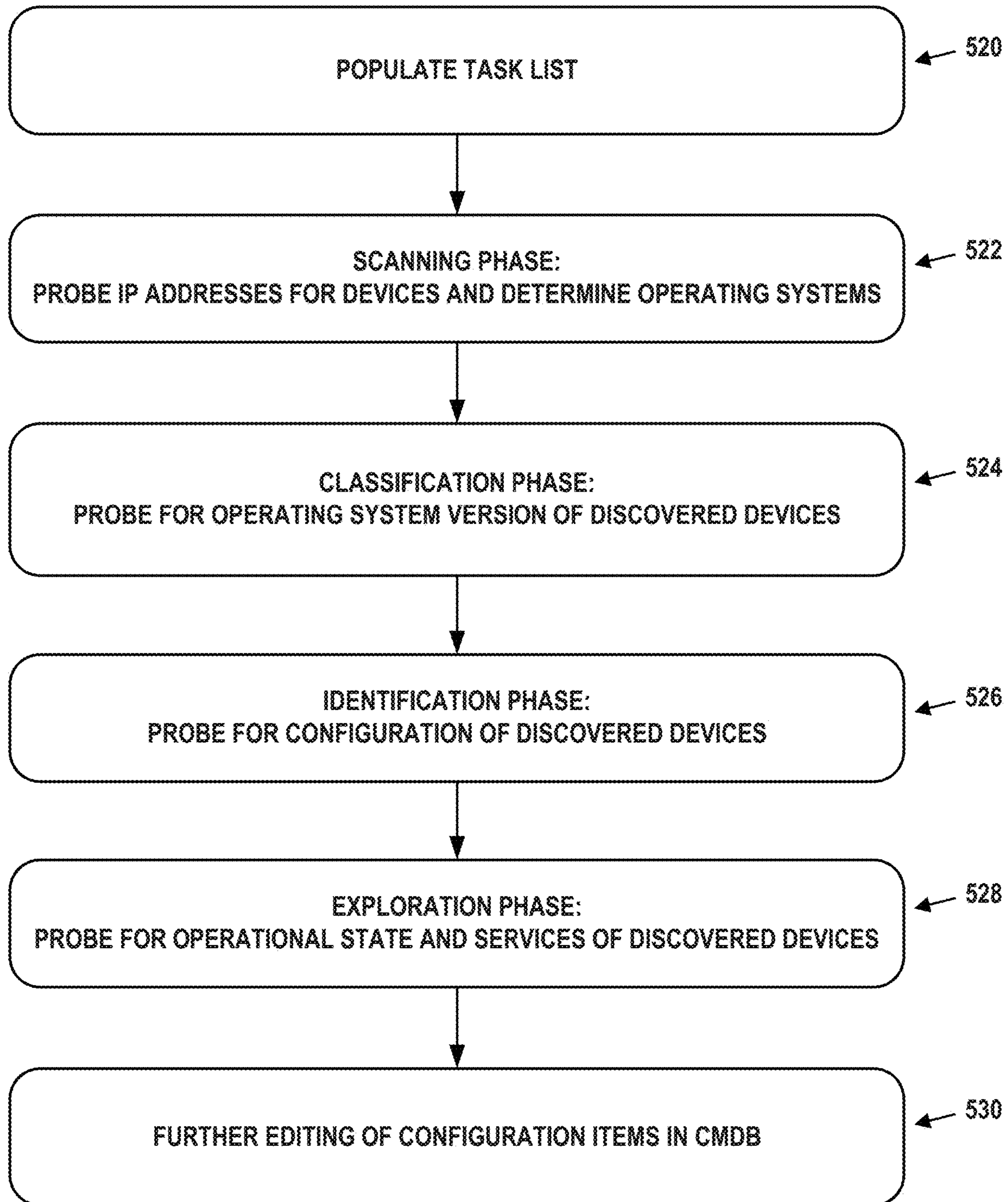


FIG. 5A



**FIG. 5B**



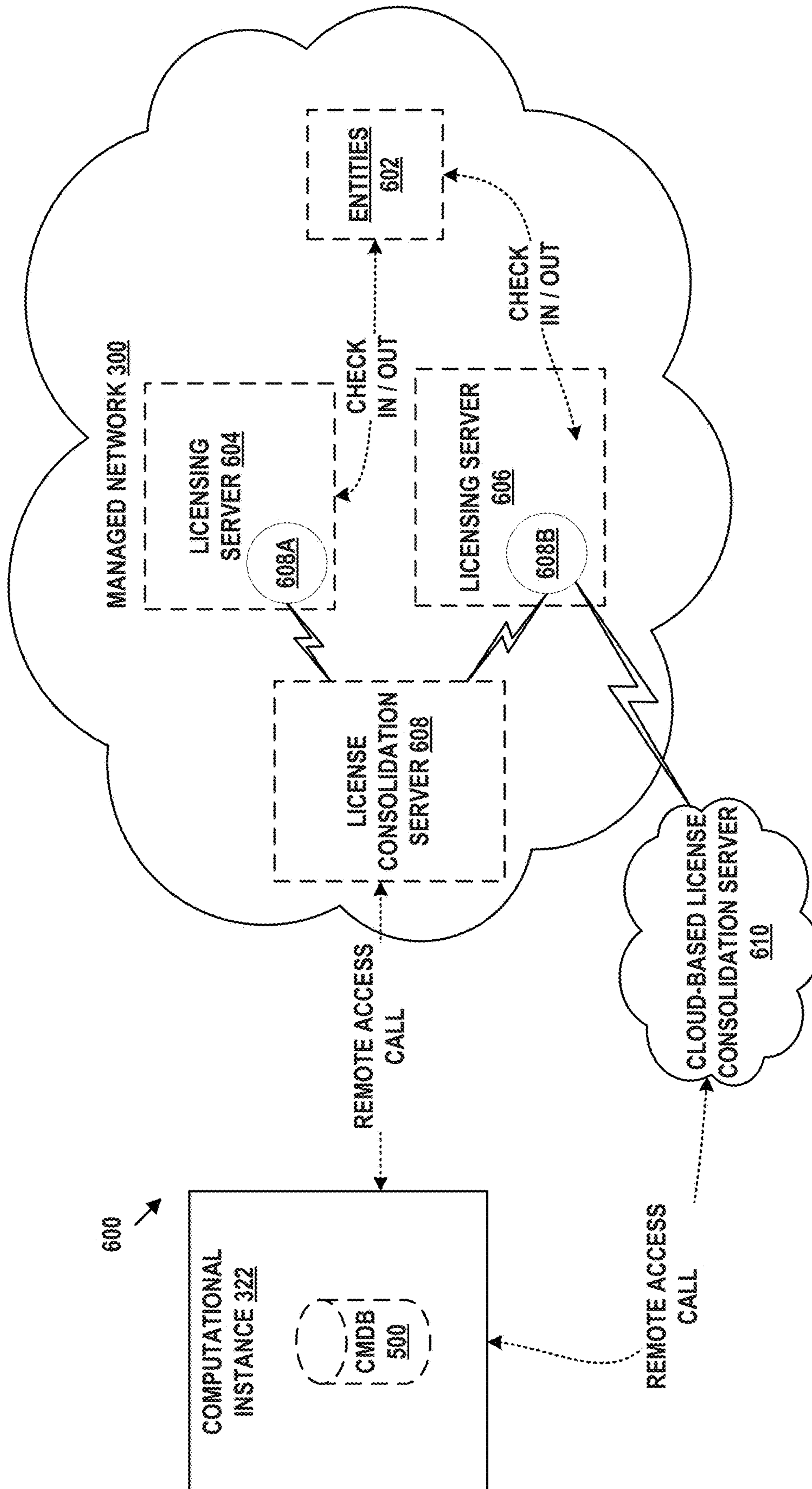


FIG. 6

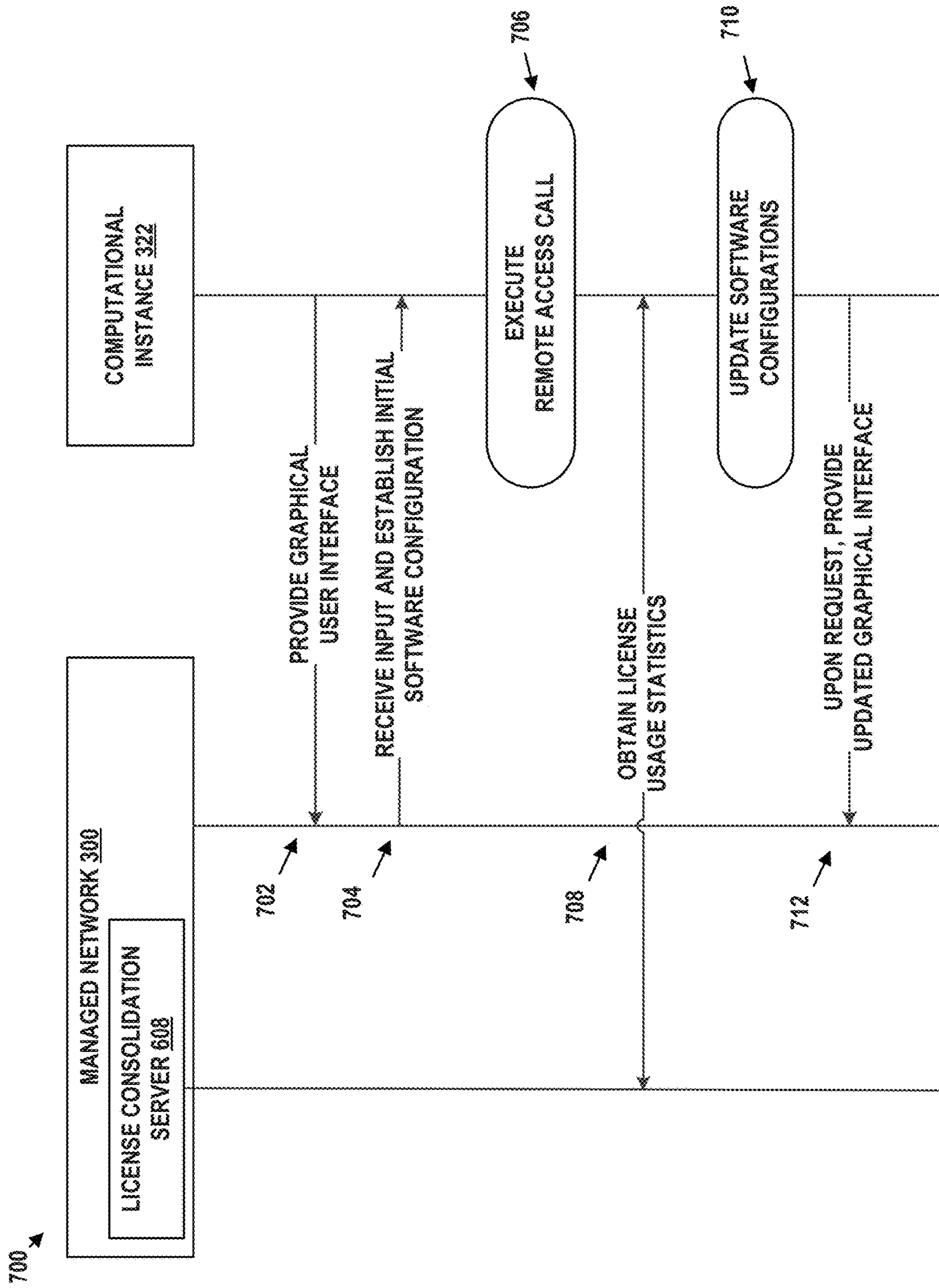


FIG. 7

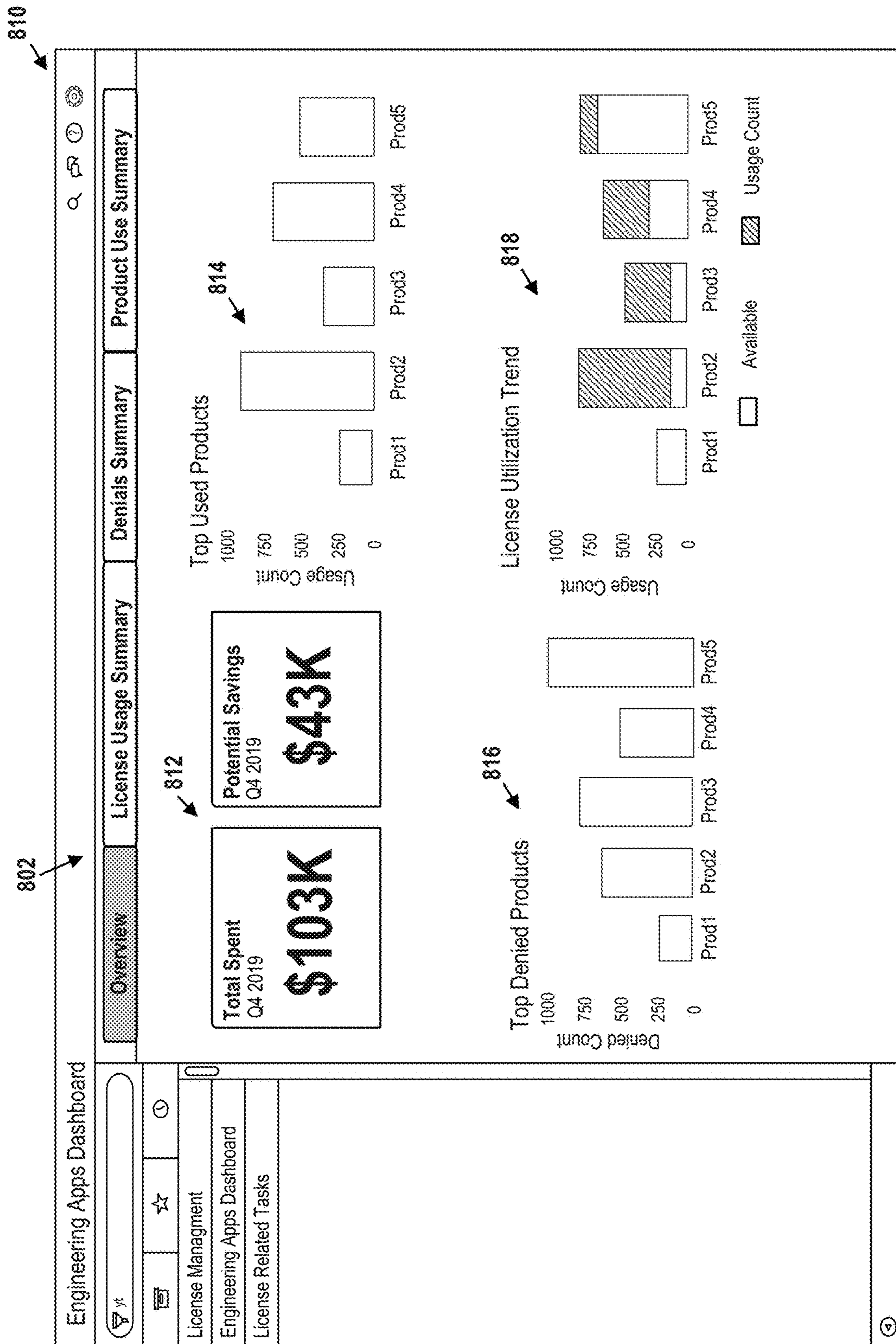


FIG. 8A

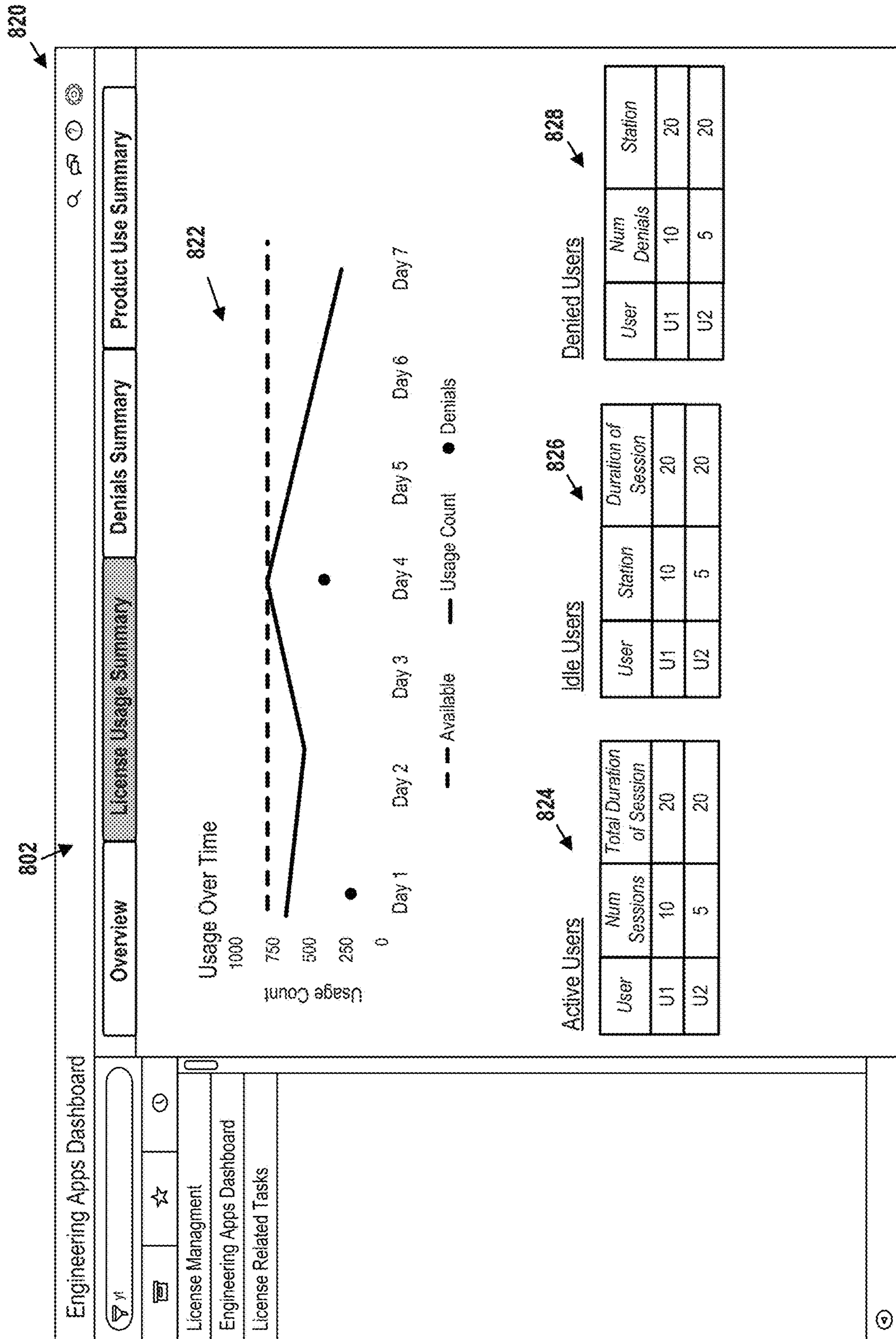


FIG. 8B

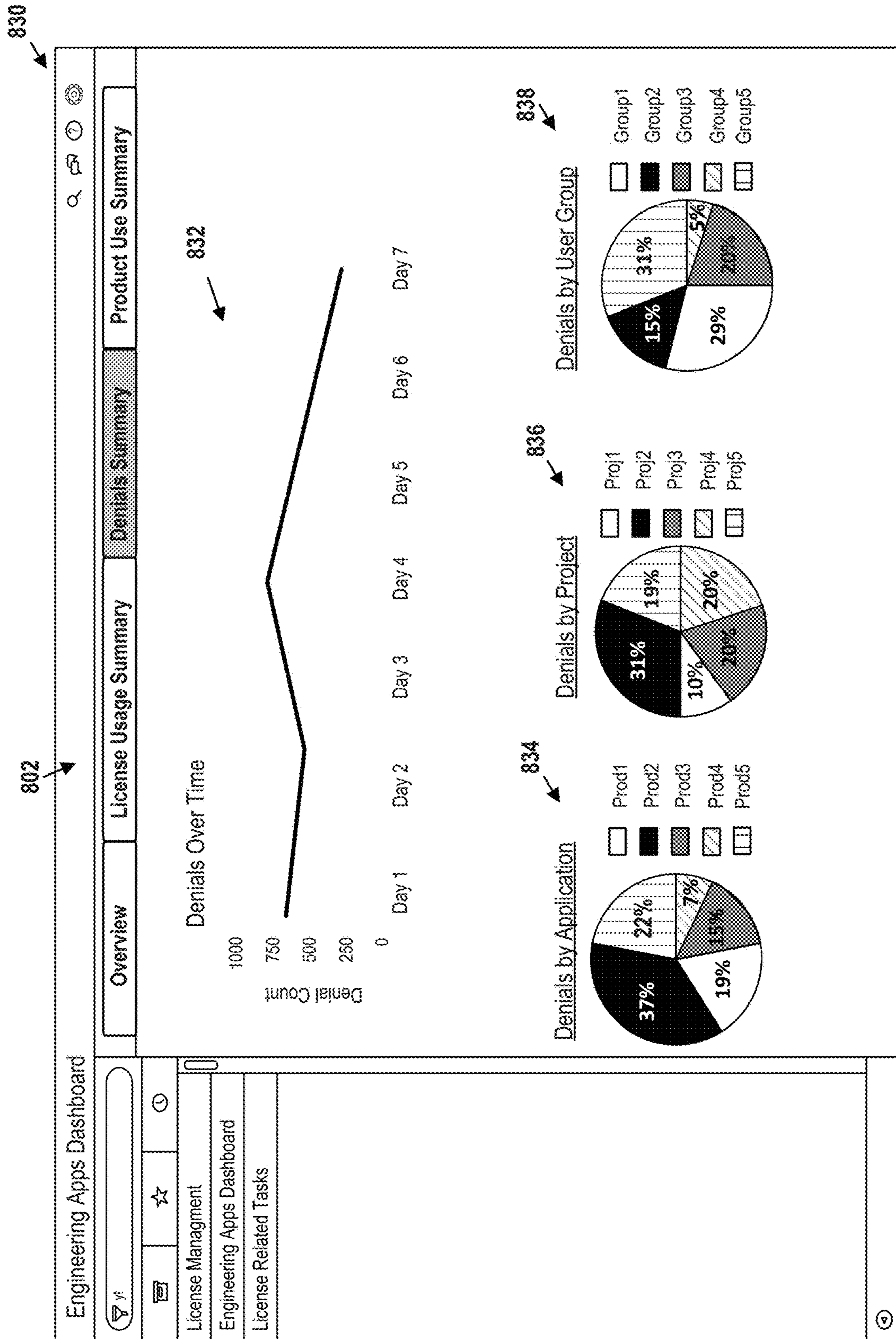


FIG. 8C

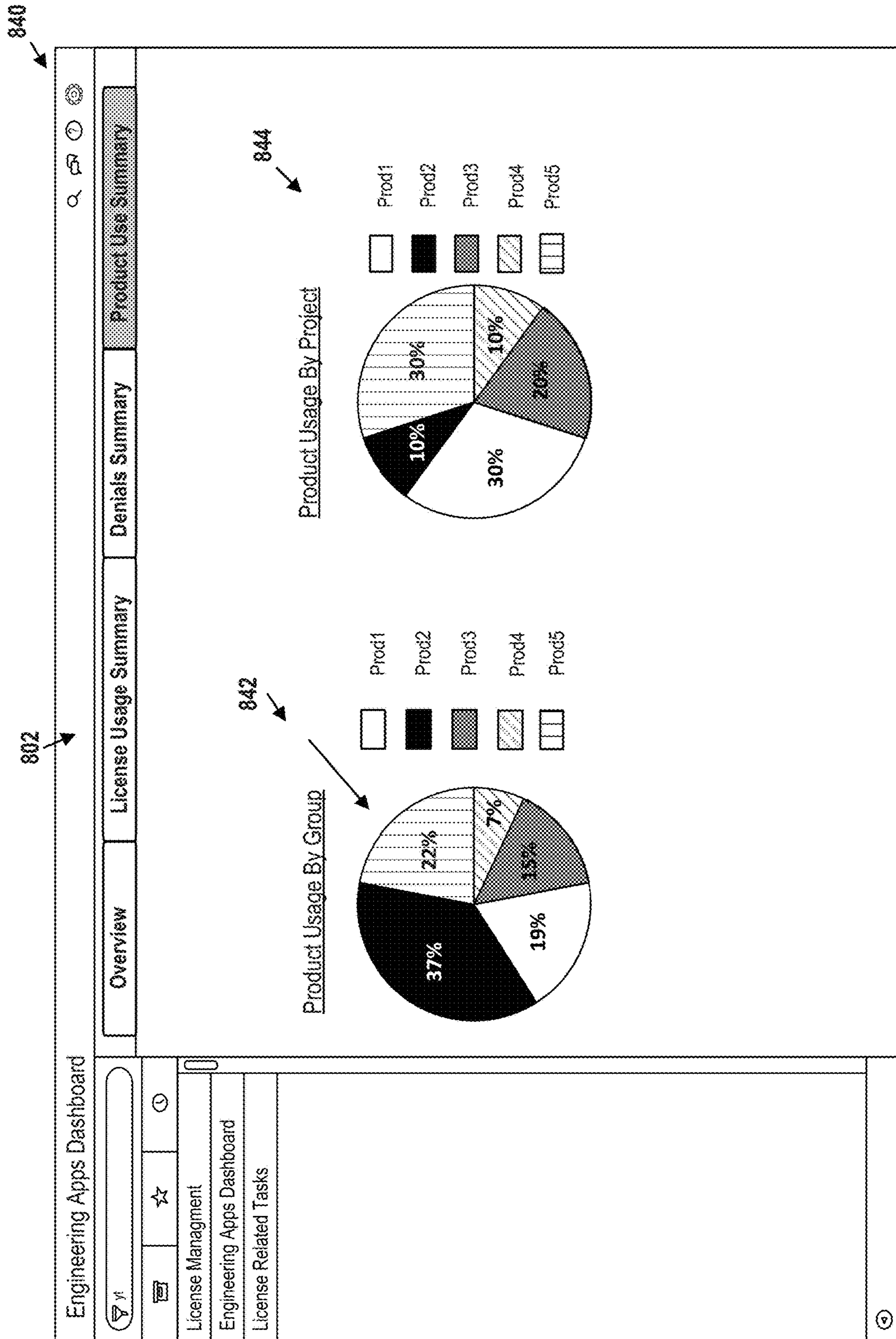


FIG. 8D

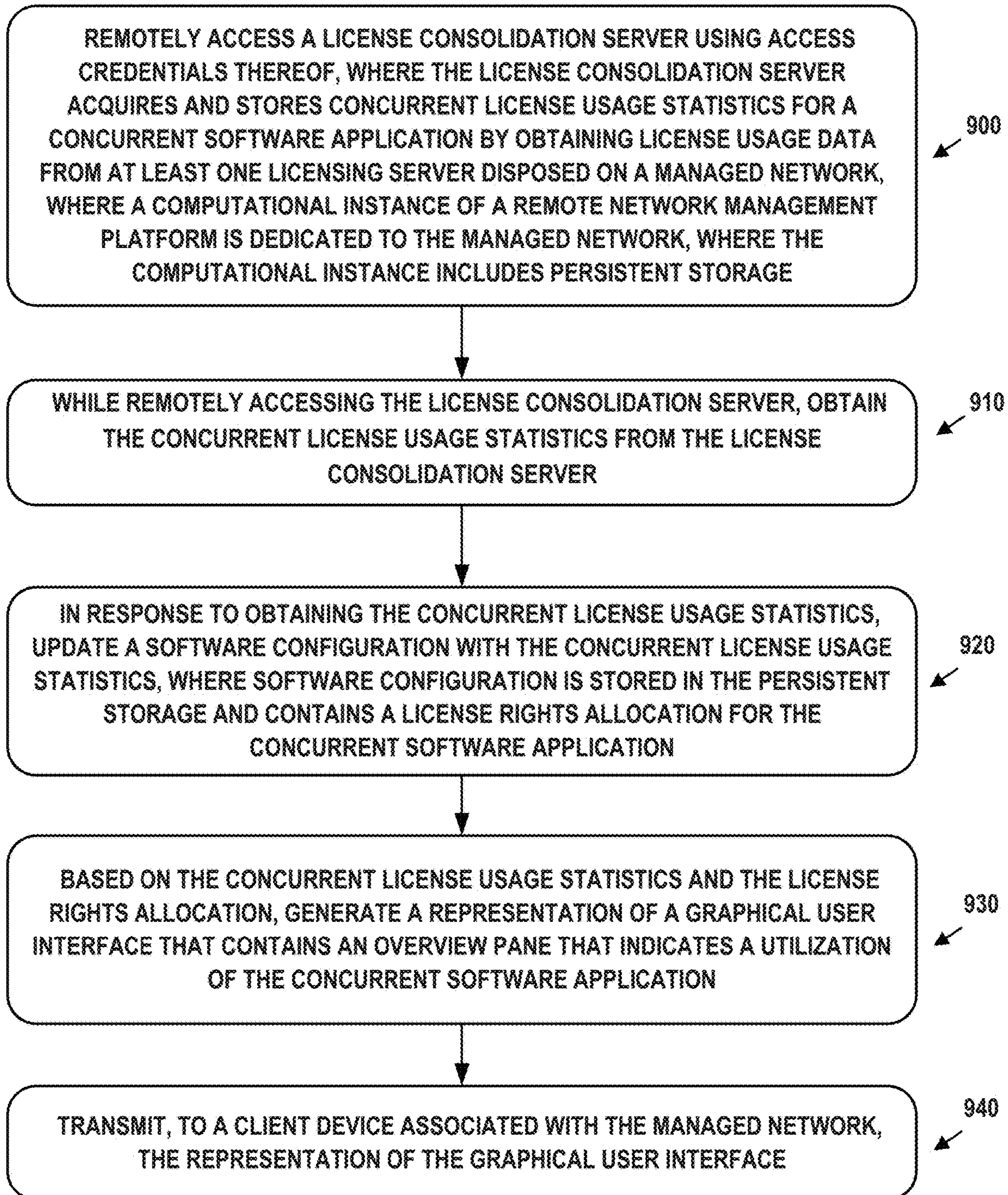


FIG. 9

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## REMOTE SOFTWARE USAGE MONITORING AND ENTITLEMENT ANALYSIS

### CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 16/565,062, entitled “REMOTE SOFTWARE USAGE MONITORING AND ENTITLEMENT ANALYSIS,” filed Sep. 9, 2019, which is hereby incorporated by reference in its entirety for all purposes.

### BACKGROUND

An enterprise may use many computing devices to efficiently facilitate and manage its various interrelated operations. Each of the computing devices may have one or more software applications installed thereon. Where the software is proprietary, the enterprise may procure licenses for the computing devices to use the software applications. Given this, the enterprise may seek to properly track license rights allocations and usage associated with the software applications, so as to determine whether the license rights usage complies with the license rights allocations and/or with other constraints imposed by the enterprise.

### SUMMARY

A managed network may use various software applications to support its operations. Often, these software applications are subject to software license agreements, which indicate how each software application can be used by the managed network. For example, a software application may be subject to a “per-device” license agreement, which specifies a number of computing/server devices on the managed network that are permitted to use the software application.

Managing the relationships between software applications and software licenses can be a complex endeavor. For one, the managed network may use thousands of separate computing devices, each of which may use different software applications. These computing devices may go in and out of service, require different software applications over time, and/or require different hardware configurations over time, among other possibilities. Moreover, certain software applications may be installed and/or uninstalled from certain computing devices without supervision or notice.

To ease this process, the managed network could use the services of a remote network management platform. In particular, the remote network management platform may operate to discover software applications installed on computing devices in the managed network, so as to establish installation counts for the software applications. Then, after a user from the managed network specifies license rights for the software applications, the remote network management platform could compare the installation counts to the license rights. As a specific example, the remote network management platform may discover that **160** instances of ADOBE ACROBAT® are installed on the managed network, when only **150** license rights are available. If this occurs, the remote network management platform may notify the managed network that it is out of compliance with the software license agreement.

While the remote network management platform is helpful, some situations may pose challenges. For example, some software applications may be subject to a concurrent license agreement (otherwise known as a “floating license”).

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Concurrent license agreements provide a pool of licenses for a software application that can be shared among users. That is, when a user wishes to run a software application subject to a concurrent license agreement they request a license from a licensing server disposed on the managed network. If a license is available from the pool, the licensing server allows the application to run. When the user is finished using the application, or when the allowed license period expires, the license is reclaimed by the licensing server and made available to other authorized users.

Because concurrent licenses are not dedicated to physical computing devices or users on the managed network, the remote network management platform may be unable to discover information about concurrent license usage. While overuse of concurrent licenses may not be a concern because the licensing servers generally don’t allow it, the managed network may find it unduly difficult to forecast future software application usage so as to prune underutilized software licenses or obtain more licenses when concurrent license utilization is high. Other problems are also possible.

Disclosed herein is a technical improvement to a remote network management platform that can address these and other issues. According to the disclosed approach, a remote network management platform could integrate with one or more licensing servers disposed on the managed network. In some cases, this integration is facilitated via one or more license consolidation servers. Once the integration is established, the remote network management platform could query each of the one or more licensing servers to obtain information about concurrent licenses usage on the managed network. Advantageously, the disclosed approach allows the managed network to properly track the allocation and usage of concurrent licenses so as to ensure license compliance and forecast future demands for concurrent software applications. Other advantages are also possible.

Accordingly, a first example embodiment may involve a computational instance of a remote network management platform. The computational instance may include persistent storage and may be dedicated to a managed network. The first example embodiment may also involve one or more processors that are configured to perform operations. These operations may include: remotely accessing a license consolidation server using access credentials thereof, where the license consolidation server acquires and stores concurrent license usage statistics for a concurrent software application by obtaining license usage data from at least one licensing server disposed on the managed network. The operations may also include, while remotely accessing the license consolidation server, obtaining the concurrent license usage statistics from the license consolidation server. The operations may also include, in response to obtaining the concurrent license usage statistics, updating a software configuration with the concurrent license usage statistics, where the software configuration is stored in the persistent storage, and where the software configuration contains a license rights allocation for the concurrent software application. The operations may also include, based on the concurrent license usage statistics and the license rights allocations, generating a representation of a graphical user interface containing an overview pane that indicates a utilization of the concurrent software application. The operations may also include, transmitting, to a client device associated with the managed network, the representation of the graphical user interface.

In a second example embodiment, an article of manufacture may include a non-transitory computer-readable medium, having stored thereon program instructions that,



upon execution by a computing system, cause the computing system to perform operations in accordance with the first example embodiment.

In a third example embodiment, a computing system may include at least one processor, as well as memory and program instructions. The program instructions may be stored in the memory, and upon execution by the at least one processor, cause the computing system to perform operations in accordance with the first example embodiment.

In a fourth example embodiment, a system may include various means for carrying out each of the operations of the first example embodiment.

These, as well as other embodiments, aspects, advantages, and alternatives, will become apparent to those of ordinary skill in the art by reading the following detailed description, with reference where appropriate to the accompanying drawings. Further, this summary and other descriptions and figures provided herein are intended to illustrate embodiments by way of example only and, as such, that numerous variations are possible. For instance, structural elements and process steps can be rearranged, combined, distributed, eliminated, or otherwise changed, while remaining within the scope of the embodiments as claimed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a schematic drawing of a computing device, in accordance with example embodiments.

FIG. 2 illustrates a schematic drawing of a server device cluster, in accordance with example embodiments.

FIG. 3 depicts a remote network management architecture, in accordance with example embodiments.

FIG. 4 depicts a communication environment involving a remote network management architecture, in accordance with example embodiments.

FIG. 5A depicts another communication environment involving a remote network management architecture, in accordance with example embodiments.

FIG. 5B is a flow chart, in accordance with example embodiments.

FIG. 6 illustrates network architecture 600, in accordance with example embodiments.

FIG. 7 depicts a message flow, in accordance with example embodiments.

FIGS. 8A-8D depict panes of web pages, in accordance with example embodiments.

FIG. 9 is a flow chart, in accordance with example embodiments.

#### DETAILED DESCRIPTION

Example methods, devices, and systems are described herein. It should be understood that the words “example” and “exemplary” are used herein to mean “serving as an example, instance, or illustration.” Any embodiment or feature described herein as being an “example” or “exemplary” is not necessarily to be construed as preferred or advantageous over other embodiments or features unless stated as such. Thus, other embodiments can be utilized and other changes can be made without departing from the scope of the subject matter presented herein.

Accordingly, the example embodiments described herein are not meant to be limiting. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the figures, can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations. For example, the

separation of features into “client” and “server” components may occur in a number of ways.

Further, unless context suggests otherwise, the features illustrated in each of the figures may be used in combination with one another. Thus, the figures should be generally viewed as component aspects of one or more overall embodiments, with the understanding that not all illustrated features are necessary for each embodiment.

Additionally, any enumeration of elements, blocks, or steps in this specification or the claims is for purposes of clarity. Thus, such enumeration should not be interpreted to require or imply that these elements, blocks, or steps adhere to a particular arrangement or are carried out in a particular order.

#### I. INTRODUCTION

A large enterprise is a complex entity with many interrelated operations. Some of these are found across the enterprise, such as human resources (HR), supply chain, information technology (IT), and finance. However, each enterprise also has its own unique operations that provide essential capabilities and/or create competitive advantages.

To support widely-implemented operations, enterprises typically use off-the-shelf software applications, such as customer relationship management (CRM) and human capital management (HCM) packages. However, they may also need custom software applications to meet their own unique requirements. A large enterprise often has dozens or hundreds of these custom software applications. Nonetheless, the advantages provided by the embodiments herein are not limited to large enterprises and may be applicable to an enterprise, or any other type of organization, of any size.

Many such software applications are developed by individual departments within the enterprise. These range from simple spreadsheets to custom-built software tools and databases. But the proliferation of siloed custom software applications has numerous disadvantages. It negatively impacts an enterprise’s ability to run and grow its operations, innovate, and meet regulatory requirements. The enterprise may find it difficult to integrate, streamline, and enhance its operations due to lack of a single system that unifies its subsystems and data.

To efficiently create custom applications, enterprises would benefit from a remotely-hosted application platform that eliminates unnecessary development complexity. The goal of such a platform would be to reduce time-consuming, repetitive application development tasks so that software engineers and individuals in other roles can focus on developing unique, high-value features.

In order to achieve this goal, the concept of Application Platform as a Service (aPaaS) is introduced, to intelligently automate workflows throughout the enterprise. An aPaaS system is hosted remotely from the enterprise, but may access data, applications, and services within the enterprise by way of secure connections. Such an aPaaS system may have a number of advantageous capabilities and characteristics. These advantages and characteristics may be able to improve the enterprise’s operations and workflows for IT, HR, CRM, customer service, application development, and security.

The aPaaS system may support development and execution of model-view-controller (MVC) applications. MVC applications divide their functionality into three interconnected parts (model, view, and controller) in order to isolate representations of information from the manner in which the information is presented to the user, thereby allowing for

efficient code reuse and parallel development. These applications may be web-based, and offer create, read, update, delete (CRUD) capabilities. This allows new applications to be built on a common application infrastructure.

The aPaaS system may support standardized application components, such as a standardized set of widgets for graphical user interface (GUI) development. In this way, applications built using the aPaaS system have a common look and feel. Other software components and modules may be standardized as well. In some cases, this look and feel can be branded or skinned with an enterprise's custom logos and/or color schemes.

The aPaaS system may support the ability to configure the behavior of applications using metadata. This allows application behaviors to be rapidly adapted to meet specific needs. Such an approach reduces development time and increases flexibility. Further, the aPaaS system may support GUI tools that facilitate metadata creation and management, thus reducing errors in the metadata.

The aPaaS system may support clearly-defined interfaces between applications, so that software developers can avoid unwanted inter-application dependencies. Thus, the aPaaS system may implement a service layer in which persistent state information and other data are stored.

The aPaaS system may support a rich set of integration features so that the applications thereon can interact with legacy applications and third-party applications. For instance, the aPaaS system may support a custom employee-onboarding system that integrates with legacy HR, IT, and accounting systems.

The aPaaS system may support enterprise-grade security. Furthermore, since the aPaaS system may be remotely hosted, it should also utilize security procedures when it interacts with systems in the enterprise or third-party networks and services hosted outside of the enterprise. For example, the aPaaS system may be configured to share data amongst the enterprise and other parties to detect and identify common security threats.

Other features, functionality, and advantages of an aPaaS system may exist. This description is for purpose of example and is not intended to be limiting.

As an example of the aPaaS development process, a software developer may be tasked to create a new application using the aPaaS system. First, the developer may define the data model, which specifies the types of data that the application uses and the relationships therebetween. Then, via a GUI of the aPaaS system, the developer enters (e.g., uploads) the data model. The aPaaS system automatically creates all of the corresponding database tables, fields, and relationships, which can then be accessed via an object-oriented services layer.

In addition, the aPaaS system can also build a fully-functional MVC application with client-side interfaces and server-side CRUD logic. This generated application may serve as the basis of further development for the user. Advantageously, the developer does not have to spend a large amount of time on basic application functionality. Further, since the application may be web-based, it can be accessed from any Internet-enabled client device. Alternatively or additionally, a local copy of the application may be able to be accessed, for instance, when Internet service is not available.

The aPaaS system may also support a rich set of pre-defined functionality that can be added to applications. These features include support for searching, email, templating, workflow design, reporting, analytics, social media, scripting, mobile-friendly output, and customized GUIs.

Such an aPaaS system may represent a GUI in various ways. For example, a server device of the aPaaS system may generate a representation of a GUI using a combination of HTML, and JAVASCRIPT®. The JAVASCRIPT® may include client-side executable code, server-side executable code, or both. The server device may transmit or otherwise provide this representation to a client device for the client device to display on a screen according to its locally-defined look and feel. Alternatively, a representation of a GUI may take other forms, such as an intermediate form (e.g., JAVA® byte-code) that a client device can use to directly generate graphical output therefrom. Other possibilities exist.

Further, user interaction with GUI elements, such as buttons, menus, tabs, sliders, checkboxes, toggles, etc. may be referred to as "selection", "activation", or "actuation" thereof. These terms may be used regardless of whether the GUI elements are interacted with by way of keyboard, pointing device, touchscreen, or another mechanism.

An aPaaS architecture is particularly powerful when integrated with an enterprise's network and used to manage such a network. The following embodiments describe architectural and functional aspects of example aPaaS systems, as well as the features and advantages thereof.

## II. EXAMPLE COMPUTING DEVICES AND CLOUD-BASED COMPUTING ENVIRONMENTS

FIG. 1 is a simplified block diagram exemplifying a computing device **100**, illustrating some of the components that could be included in a computing device arranged to operate in accordance with the embodiments herein. Computing device **100** could be a client device (e.g., a device actively operated by a user), a server device (e.g., a device that provides computational services to client devices), or some other type of computational platform. Some server devices may operate as client devices from time to time in order to perform particular operations, and some client devices may incorporate server features.

In this example, computing device **100** includes processor **102**, memory **104**, network interface **106**, and input/output unit **108**, all of which may be coupled by system bus **110** or a similar mechanism. In some embodiments, computing device **100** may include other components and/or peripheral devices (e.g., detachable storage, printers, and so on).

Processor **102** may be one or more of any type of computer processing element, such as a central processing unit (CPU), a co-processor (e.g., a mathematics, graphics, or encryption co-processor), a digital signal processor (DSP), a network processor, and/or a form of integrated circuit or controller that performs processor operations. In some cases, processor **102** may be one or more single-core processors. In other cases, processor **102** may be one or more multi-core processors with multiple independent processing units. Processor **102** may also include register memory for temporarily storing instructions being executed and related data, as well as cache memory for temporarily storing recently-used instructions and data.

Memory **104** may be any form of computer-usable memory, including but not limited to random access memory (RAM), read-only memory (ROM), and non-volatile memory (e.g., flash memory, hard disk drives, solid state drives, compact discs (CDs), digital video discs (DVDs), and/or tape storage). Thus, memory **104** represents both main memory units, as well as long-term storage. Other types of memory may include biological memory.

Memory **104** may store program instructions and/or data on which program instructions may operate. By way of example, memory **104** may store these program instructions on a non-transitory, computer-readable medium, such that the instructions are executable by processor **102** to carry out any of the methods, processes, or operations disclosed in this specification or the accompanying drawings.

As shown in FIG. **1**, memory **104** may include firmware **104A**, kernel **104B**, and/or applications **104C**. Firmware **104A** may be program code used to boot or otherwise initiate some or all of computing device **100**. Kernel **104B** may be an operating system, including modules for memory management, scheduling and management of processes, input/output, and communication. Kernel **104B** may also include device drivers that allow the operating system to communicate with the hardware modules (e.g., memory units, networking interfaces, ports, and buses) of computing device **100**. Applications **104C** may be one or more user-space software programs, such as web browsers or email clients, as well as any software libraries used by these programs. Memory **104** may also store data used by these and other programs and applications.

Network interface **106** may take the form of one or more wireline interfaces, such as Ethernet (e.g., Fast Ethernet, Gigabit Ethernet, and so on). Network interface **106** may also support communication over one or more non-Ethernet media, such as coaxial cables or power lines, or over wide-area media, such as Synchronous Optical Networking (SONET) or digital subscriber line (DSL) technologies. Network interface **106** may additionally take the form of one or more wireless interfaces, such as IEEE 802.11 (Wifi), BLUETOOTH®, global positioning system (GPS), or a wide-area wireless interface. However, other forms of physical layer interfaces and other types of standard or proprietary communication protocols may be used over network interface **106**. Furthermore, network interface **106** may comprise multiple physical interfaces. For instance, some embodiments of computing device **100** may include Ethernet, BLUETOOTH®, and Wifi interfaces.

Input/output unit **108** may facilitate user and peripheral device interaction with computing device **100**. Input/output unit **108** may include one or more types of input devices, such as a keyboard, a mouse, a touch screen, and so on. Similarly, input/output unit **108** may include one or more types of output devices, such as a screen, monitor, printer, and/or one or more light emitting diodes (LEDs). Additionally or alternatively, computing device **100** may communicate with other devices using a universal serial bus (USB) or high-definition multimedia interface (HDMI) port interface, for example.

In some embodiments, one or more computing devices like computing device **100** may be deployed to support an aPaaS architecture. The exact physical location, connectivity, and configuration of these computing devices may be unknown and/or unimportant to client devices. Accordingly, the computing devices may be referred to as “cloud-based” devices that may be housed at various remote data center locations.

FIG. **2** depicts a cloud-based server cluster **200** in accordance with example embodiments. In FIG. **2**, operations of a computing device (e.g., computing device **100**) may be distributed between server devices **202**, data storage **204**, and routers **206**, all of which may be connected by local cluster network **208**. The number of server devices **202**, data storages **204**, and routers **206** in server cluster **200** may depend on the computing task(s) and/or applications assigned to server cluster **200**.

For example, server devices **202** can be configured to perform various computing tasks of computing device **100**. Thus, computing tasks can be distributed among one or more of server devices **202**. To the extent that these computing tasks can be performed in parallel, such a distribution of tasks may reduce the total time to complete these tasks and return a result. For purposes of simplicity, both server cluster **200** and individual server devices **202** may be referred to as a “server device.” This nomenclature should be understood to imply that one or more distinct server devices, data storage devices, and cluster routers may be involved in server device operations.

Data storage **204** may be data storage arrays that include drive array controllers configured to manage read and write access to groups of hard disk drives and/or solid state drives. The drive array controllers, alone or in conjunction with server devices **202**, may also be configured to manage backup or redundant copies of the data stored in data storage **204** to protect against drive failures or other types of failures that prevent one or more of server devices **202** from accessing units of data storage **204**. Other types of memory aside from drives may be used.

Routers **206** may include networking equipment configured to provide internal and external communications for server cluster **200**. For example, routers **206** may include one or more packet-switching and/or routing devices (including switches and/or gateways) configured to provide (i) network communications between server devices **202** and data storage **204** via local cluster network **208**, and/or (ii) network communications between server cluster **200** and other devices via communication link **210** to network **212**.

Additionally, the configuration of routers **206** can be based at least in part on the data communication requirements of server devices **202** and data storage **204**, the latency and throughput of the local cluster network **208**, the latency, throughput, and cost of communication link **210**, and/or other factors that may contribute to the cost, speed, fault-tolerance, resiliency, efficiency, and/or other design goals of the system architecture.

As a possible example, data storage **204** may include any form of database, such as a structured query language (SQL) database. Various types of data structures may store the information in such a database, including but not limited to tables, arrays, lists, trees, and tuples. Furthermore, any databases in data storage **204** may be monolithic or distributed across multiple physical devices.

Server devices **202** may be configured to transmit data to and receive data from data storage **204**. This transmission and retrieval may take the form of SQL queries or other types of database queries, and the output of such queries, respectively. Additional text, images, video, and/or audio may be included as well. Furthermore, server devices **202** may organize the received data into web page or web application representations. Such a representation may take the form of a markup language, such as the hypertext markup language (HTML), the extensible markup language (XML), or some other standardized or proprietary format. Moreover, server devices **202** may have the capability of executing various types of computerized scripting languages, such as but not limited to Perl, Python, PHP Hypertext Preprocessor (PHP), Active Server Pages (ASP), JAVASCRIPT®, and so on. Computer program code written in these languages may facilitate the providing of web pages to client devices, as well as client device interaction with the web pages. Alternatively or additionally, JAVA® may be used to facilitate generation of web pages and/or to provide web application functionality.

### III. EXAMPLE REMOTE NETWORK MANAGEMENT ARCHITECTURE

FIG. 3 depicts a remote network management architecture, in accordance with example embodiments. This architecture includes three main components—managed network 300, remote network management platform 320, and public cloud networks 340—all connected by way of Internet 350.

#### A. Managed Networks

Managed network 300 may be, for example, an enterprise network used by an entity for computing and communications tasks, as well as storage of data. Thus, managed network 300 may include client devices 302, server devices 304, routers 306, virtual machines 308, firewall 310, and/or proxy servers 312. Client devices 302 may be embodied by computing device 100, server devices 304 may be embodied by computing device 100 or server cluster 200, and routers 306 may be any type of router, switch, or gateway.

Virtual machines 308 may be embodied by one or more of computing device 100 or server cluster 200. In general, a virtual machine is an emulation of a computing system, and mimics the functionality (e.g., processor, memory, and communication resources) of a physical computer. One physical computing system, such as server cluster 200, may support up to thousands of individual virtual machines. In some embodiments, virtual machines 308 may be managed by a centralized server device or application that facilitates allocation of physical computing resources to individual virtual machines, as well as performance and error reporting. Enterprises often employ virtual machines in order to allocate computing resources in an efficient, as needed fashion. Providers of virtualized computing systems include VMWARE® and MICROSOFT®.

Firewall 310 may be one or more specialized routers or server devices that protect managed network 300 from unauthorized attempts to access the devices, applications, and services therein, while allowing authorized communication that is initiated from managed network 300. Firewall 310 may also provide intrusion detection, web filtering, virus scanning, application-layer gateways, and other applications or services. In some embodiments not shown in FIG. 3, managed network 300 may include one or more virtual private network (VPN) gateways with which it communicates with remote network management platform 320 (see below).

Managed network 300 may also include one or more proxy servers 312. An embodiment of proxy servers 312 may be a server application that facilitates communication and movement of data between managed network 300, remote network management platform 320, and public cloud networks 340. In particular, proxy servers 312 may be able to establish and maintain secure communication sessions with one or more computational instances of remote network management platform 320. By way of such a session, remote network management platform 320 may be able to discover and manage aspects of the architecture and configuration of managed network 300 and its components. Possibly with the assistance of proxy servers 312, remote network management platform 320 may also be able to discover and manage aspects of public cloud networks 340 that are used by managed network 300.

Firewalls, such as firewall 310, typically deny all communication sessions that are incoming by way of Internet 350, unless such a session was ultimately initiated from behind the firewall (i.e., from a device on managed network 300) or the firewall has been explicitly configured to support the session. By placing proxy servers 312 behind firewall

310 (e.g., within managed network 300 and protected by firewall 310), proxy servers 312 may be able to initiate these communication sessions through firewall 310. Thus, firewall 310 might not have to be specifically configured to support incoming sessions from remote network management platform 320, thereby avoiding potential security risks to managed network 300.

In some cases, managed network 300 may consist of a few devices and a small number of networks. In other deployments, managed network 300 may span multiple physical locations and include hundreds of networks and hundreds of thousands of devices. Thus, the architecture depicted in FIG. 3 is capable of scaling up or down by orders of magnitude.

Furthermore, depending on the size, architecture, and connectivity of managed network 300, a varying number of proxy servers 312 may be deployed therein. For example, each one of proxy servers 312 may be responsible for communicating with remote network management platform 320 regarding a portion of managed network 300. Alternatively or additionally, sets of two or more proxy servers may be assigned to such a portion of managed network 300 for purposes of load balancing, redundancy, and/or high availability.

#### B. Remote Network Management Platforms

Remote network management platform 320 is a hosted environment that provides aPaaS services to users, particularly to the operator of managed network 300. These services may take the form of web-based portals, for example, using the aforementioned web-based technologies. Thus, a user can securely access remote network management platform 320 from, for example, client devices 302, or potentially from a client device outside of managed network 300. By way of the web-based portals, users may design, test, and deploy applications, generate reports, view analytics, and perform other tasks.

As shown in FIG. 3, remote network management platform 320 includes four computational instances 322, 324, 326, and 328. Each of these computational instances may represent one or more server nodes operating dedicated copies of the aPaaS software and/or one or more database nodes. The arrangement of server and database nodes on physical server devices and/or virtual machines can be flexible and may vary based on enterprise needs. In combination, these nodes may provide a set of web portals, services, and applications (e.g., a wholly-functioning aPaaS system) available to a particular enterprise. In some cases, a single enterprise may use multiple computational instances.

For example, managed network 300 may be an enterprise customer of remote network management platform 320, and may use computational instances 322, 324, and 326. The reason for providing multiple computational instances to one customer is that the customer may wish to independently develop, test, and deploy its applications and services. Thus, computational instance 322 may be dedicated to application development related to managed network 300, computational instance 324 may be dedicated to testing these applications, and computational instance 326 may be dedicated to the live operation of tested applications and services. A computational instance may also be referred to as a hosted instance, a remote instance, a customer instance, or by some other designation. Any application deployed onto a computational instance may be a scoped application, in that its access to databases within the computational instance can be restricted to certain elements therein (e.g., one or more particular database tables or particular rows within one or more database tables).

For purposes of clarity, the disclosure herein refers to the arrangement of application nodes, database nodes, aPaaS software executing thereon, and underlying hardware as a “computational instance.” Note that users may colloquially refer to the graphical user interfaces provided thereby as “instances.” But unless it is defined otherwise herein, a “computational instance” is a computing system disposed within remote network management platform **320**.

The multi-instance architecture of remote network management platform **320** is in contrast to conventional multi-tenant architectures, over which multi-instance architectures exhibit several advantages. In multi-tenant architectures, data from different customers (e.g., enterprises) are comingled in a single database. While these customers’ data are separate from one another, the separation is enforced by the software that operates the single database. As a consequence, a security breach in this system may impact all customers’ data, creating additional risk, especially for entities subject to governmental, healthcare, and/or financial regulation. Furthermore, any database operations that impact one customer will likely impact all customers sharing that database. Thus, if there is an outage due to hardware or software errors, this outage affects all such customers. Likewise, if the database is to be upgraded to meet the needs of one customer, it will be unavailable to all customers during the upgrade process. Often, such maintenance windows will be long, due to the size of the shared database.

In contrast, the multi-instance architecture provides each customer with its own database in a dedicated computing instance. This prevents comingling of customer data, and allows each instance to be independently managed. For example, when one customer’s instance experiences an outage due to errors or an upgrade, other computational instances are not impacted. Maintenance down time is limited because the database only contains one customer’s data. Further, the simpler design of the multi-instance architecture allows redundant copies of each customer database and instance to be deployed in a geographically diverse fashion. This facilitates high availability, where the live version of the customer’s instance can be moved when faults are detected or maintenance is being performed.

In some embodiments, remote network management platform **320** may include one or more central instances, controlled by the entity that operates this platform. Like a computational instance, a central instance may include some number of application and database nodes disposed upon some number of physical server devices or virtual machines. Such a central instance may serve as a repository for specific configurations of computational instances as well as data that can be shared amongst at least some of the computational instances. For instance, definitions of common security threats that could occur on the computational instances, software packages that are commonly discovered on the computational instances, and/or an application store for applications that can be deployed to the computational instances may reside in a central instance. Computational instances may communicate with central instances by way of well-defined interfaces in order to obtain this data.

In order to support multiple computational instances in an efficient fashion, remote network management platform **320** may implement a plurality of these instances on a single hardware platform. For example, when the aPaaS system is implemented on a server cluster such as server cluster **200**, it may operate virtual machines that dedicate varying amounts of computational, storage, and communication resources to instances. But full virtualization of server cluster **200** might not be necessary, and other mechanisms

may be used to separate instances. In some examples, each instance may have a dedicated account and one or more dedicated databases on server cluster **200**. Alternatively, a computational instance such as computational instance **322** may span multiple physical devices.

In some cases, a single server cluster of remote network management platform **320** may support multiple independent enterprises. Furthermore, as described below, remote network management platform **320** may include multiple server clusters deployed in geographically diverse data centers in order to facilitate load balancing, redundancy, and/or high availability.

#### C. Public Cloud Networks

Public cloud networks **340** may be remote server devices (e.g., a plurality of server clusters such as server cluster **200**) that can be used for outsourced computation, data storage, communication, and service hosting operations. These servers may be virtualized (i.e., the servers may be virtual machines). Examples of public cloud networks **340** may include AMAZON WEB SERVICES® and MICROSOFT® AZURE®. Like remote network management platform **320**, multiple server clusters supporting public cloud networks **340** may be deployed at geographically diverse locations for purposes of load balancing, redundancy, and/or high availability.

Managed network **300** may use one or more of public cloud networks **340** to deploy applications and services to its clients and customers. For instance, if managed network **300** provides online music streaming services, public cloud networks **340** may store the music files and provide web interface and streaming capabilities. In this way, the enterprise of managed network **300** does not have to build and maintain its own servers for these operations.

Remote network management platform **320** may include modules that integrate with public cloud networks **340** to expose virtual machines and managed services therein to managed network **300**. The modules may allow users to request virtual resources, discover allocated resources, and provide flexible reporting for public cloud networks **340**. In order to establish this functionality, a user from managed network **300** might first establish an account with public cloud networks **340**, and request a set of associated resources. Then, the user may enter the account information into the appropriate modules of remote network management platform **320**. These modules may then automatically discover the manageable resources in the account, and also provide reports related to usage, performance, and billing.

#### D. Communication Support and Other Operations

Internet **350** may represent a portion of the global Internet. However, Internet **350** may alternatively represent a different type of network, such as a private wide-area or local-area packet-switched network.

FIG. 4 further illustrates the communication environment between managed network **300** and computational instance **322**, and introduces additional features and alternative embodiments. In FIG. 4, computational instance **322** is replicated across data centers **400A** and **400B**. These data centers may be geographically distant from one another, perhaps in different cities or different countries. Each data center includes support equipment that facilitates communication with managed network **300**, as well as remote users.

In data center **400A**, network traffic to and from external devices flows either through VPN gateway **402A** or firewall **404A**. VPN gateway **402A** may be peered with VPN gateway **412** of managed network **300** by way of a security protocol such as Internet Protocol Security (IPSEC) or Transport Layer Security (TLS). Firewall **404A** may be

configured to allow access from authorized users, such as user **414** and remote user **416**, and to deny access to unauthorized users. By way of firewall **404A**, these users may access computational instance **322**, and possibly other computational instances. Load balancer **406A** may be used to distribute traffic amongst one or more physical or virtual server devices that host computational instance **322**. Load balancer **406A** may simplify user access by hiding the internal configuration of data center **400A**, (e.g., computational instance **322**) from client devices. For instance, if computational instance **322** includes multiple physical or virtual computing devices that share access to multiple databases, load balancer **406A** may distribute network traffic and processing tasks across these computing devices and databases so that no one computing device or database is significantly busier than the others. In some embodiments, computational instance **322** may include VPN gateway **402A**, firewall **404A**, and load balancer **406A**.

Data center **400B** may include its own versions of the components in data center **400A**. Thus, VPN gateway **402B**, firewall **404B**, and load balancer **406B** may perform the same or similar operations as VPN gateway **402A**, firewall **404A**, and load balancer **406A**, respectively. Further, by way of real-time or near-real-time database replication and/or other operations, computational instance **322** may exist simultaneously in data centers **400A** and **400B**.

Data centers **400A** and **400B** as shown in FIG. 4 may facilitate redundancy and high availability. In the configuration of FIG. 4, data center **400A** is active and data center **400B** is passive. Thus, data center **400A** is serving all traffic to and from managed network **300**, while the version of computational instance **322** in data center **400B** is being updated in near-real-time. Other configurations, such as one in which both data centers are active, may be supported.

Should data center **400A** fail in some fashion or otherwise become unavailable to users, data center **400B** can take over as the active data center. For example, domain name system (DNS) servers that associate a domain name of computational instance **322** with one or more Internet Protocol (IP) addresses of data center **400A** may re-associate the domain name with one or more IP addresses of data center **400B**. After this re-association completes (which may take less than one second or several seconds), users may access computational instance **322** by way of data center **400B**.

FIG. 4 also illustrates a possible configuration of managed network **300**. As noted above, proxy servers **312** and user **414** may access computational instance **322** through firewall **310**. Proxy servers **312** may also access configuration items **410**. In FIG. 4, configuration items **410** may refer to any or all of client devices **302**, server devices **304**, routers **306**, and virtual machines **308**, any applications or services executing thereon, as well as relationships between devices, applications, and services. Thus, the term “configuration items” may be shorthand for any physical or virtual device, or any application or service remotely discoverable or managed by computational instance **322**, or relationships between discovered devices, applications, and services. Configuration items may be represented in a configuration management database (CMDB) of computational instance **322**.

As noted above, VPN gateway **412** may provide a dedicated VPN to VPN gateway **402A**. Such a VPN may be helpful when there is a significant amount of traffic between managed network **300** and computational instance **322**, or security policies otherwise suggest or require use of a VPN between these sites. In some embodiments, any device in managed network **300** and/or computational instance **322** that directly communicates via the VPN is assigned a public

IP address. Other devices in managed network **300** and/or computational instance **322** may be assigned private IP addresses (e.g., IP addresses selected from the 10.0.0.0-10.255.255.255 or 192.168.0.0-192.168.255.255 ranges, represented in shorthand as subnets 10.0.0.0/8 and 192.168.0.0/16, respectively).

#### IV. EXAMPLE DEVICE, APPLICATION, AND SERVICE DISCOVERY

In order for remote network management platform **320** to administer the devices, applications, and services of managed network **300**, remote network management platform **320** may first determine what devices are present in managed network **300**, the configurations and operational statuses of these devices, and the applications and services provided by the devices, as well as the relationships between discovered devices, applications, and services. As noted above, each device, application, service, and relationship may be referred to as a configuration item. The process of defining configuration items within managed network **300** is referred to as discovery, and may be facilitated at least in part by proxy servers **312**.

For purposes of the embodiments herein, an “application” may refer to one or more processes, threads, programs, client modules, server modules, or any other software that executes on a device or group of devices. A “service” may refer to a high-level capability provided by multiple applications executing on one or more devices working in conjunction with one another. For example, a high-level web service may involve multiple web application server threads executing on one device and accessing information from a database application that executes on another device.

FIG. 5A provides a logical depiction of how configuration items can be discovered, as well as how information related to discovered configuration items can be stored. For sake of simplicity, remote network management platform **320**, public cloud networks **340**, and Internet **350** are not shown.

In FIG. 5A, CMDB **500** and task list **502** are stored within computational instance **322**. Computational instance **322** may transmit discovery commands to proxy servers **312**. In response, proxy servers **312** may transmit probes to various devices, applications, and services in managed network **300**. These devices, applications, and services may transmit responses to proxy servers **312**, and proxy servers **312** may then provide information regarding discovered configuration items to CMDB **500** for storage therein. Configuration items stored in CMDB **500** represent the environment of managed network **300**.

Task list **502** represents a list of activities that proxy servers **312** are to perform on behalf of computational instance **322**. As discovery takes place, task list **502** is populated. Proxy servers **312** repeatedly query task list **502**, obtain the next task therein, and perform this task until task list **502** is empty or another stopping condition has been reached.

To facilitate discovery, proxy servers **312** may be configured with information regarding one or more subnets in managed network **300** that are reachable by way of proxy servers **312**. For instance, proxy servers **312** may be given the IP address range 192.168.0/24 as a subnet. Then, computational instance **322** may store this information in CMDB **500** and place tasks in task list **502** for discovery of devices at each of these addresses.

FIG. 5A also depicts devices, applications, and services in managed network **300** as configuration items **504**, **506**, **508**, **510**, and **512**. As noted above, these configuration items

represent a set of physical and/or virtual devices (e.g., client devices, server devices, routers, or virtual machines), applications executing thereon (e.g., web servers, email servers, databases, or storage arrays), relationships therebetween, as well as services that involve multiple individual configuration items.

Placing the tasks in task list **502** may trigger or otherwise cause proxy servers **312** to begin discovery. Alternatively or additionally, discovery may be manually triggered or automatically triggered based on triggering events (e.g., discovery may automatically begin once per day at a particular time).

In general, discovery may proceed in four logical phases: scanning, classification, identification, and exploration. Each phase of discovery involves various types of probe messages being transmitted by proxy servers **312** to one or more devices in managed network **300**. The responses to these probes may be received and processed by proxy servers **312**, and representations thereof may be transmitted to CMDB **500**. Thus, each phase can result in more configuration items being discovered and stored in CMDB **500**.

In the scanning phase, proxy servers **312** may probe each IP address in the specified range of IP addresses for open Transmission Control Protocol (TCP) and/or User Datagram Protocol (UDP) ports to determine the general type of device. The presence of such open ports at an IP address may indicate that a particular application is operating on the device that is assigned the IP address, which in turn may identify the operating system used by the device. For example, if TCP port **135** is open, then the device is likely executing a WINDOWS® operating system. Similarly, if TCP port **22** is open, then the device is likely executing a UNIX® operating system, such as LINUX®. If UDP port **161** is open, then the device may be able to be further identified through the Simple Network Management Protocol (SNMP). Other possibilities exist. Once the presence of a device at a particular IP address and its open ports have been discovered, these configuration items are saved in CMDB **500**.

In the classification phase, proxy servers **312** may further probe each discovered device to determine the version of its operating system. The probes used for a particular device are based on information gathered about the devices during the scanning phase. For example, if a device is found with TCP port **22** open, a set of UNIX®-specific probes may be used. Likewise, if a device is found with TCP port **135** open, a set of WINDOWS®-specific probes may be used. For either case, an appropriate set of tasks may be placed in task list **502** for proxy servers **312** to carry out. These tasks may result in proxy servers **312** logging on, or otherwise accessing information from the particular device. For instance, if TCP port **22** is open, proxy servers **312** may be instructed to initiate a Secure Shell (SSH) connection to the particular device and obtain information about the operating system thereon from particular locations in the file system. Based on this information, the operating system may be determined. As an example, a UNIX® device with TCP port **22** open may be classified as AIX®, HPUX, LINUX®, MACOS®, or SOLARIS®. This classification information may be stored as one or more configuration items in CMDB **500**.

In the identification phase, proxy servers **312** may determine specific details about a classified device. The probes used during this phase may be based on information gathered about the particular devices during the classification phase. For example, if a device was classified as LINUX®, a set of LINUX®-specific probes may be used. Likewise, if a device was classified as WINDOWS® 2012, as a set of

WINDOWS®-2012-specific probes may be used. As was the case for the classification phase, an appropriate set of tasks may be placed in task list **502** for proxy servers **312** to carry out. These tasks may result in proxy servers **312** reading information from the particular device, such as basic input/output system (BIOS) information, serial numbers, network interface information, media access control address(es) assigned to these network interface(s), IP address(es) used by the particular device and so on. This identification information may be stored as one or more configuration items in CMDB **500**.

In the exploration phase, proxy servers **312** may determine further details about the operational state of a classified device. The probes used during this phase may be based on information gathered about the particular devices during the classification phase and/or the identification phase. Again, an appropriate set of tasks may be placed in task list **502** for proxy servers **312** to carry out. These tasks may result in proxy servers **312** reading additional information from the particular device, such as processor information, memory information, lists of running processes (applications), and so on. Once more, the discovered information may be stored as one or more configuration items in CMDB **500**.

Running discovery on a network device, such as a router, may utilize SNMP. Instead of or in addition to determining a list of running processes or other application-related information, discovery may determine additional subnets known to the router and the operational state of the router's network interfaces (e.g., active, inactive, queue length, number of packets dropped, etc.). The IP addresses of the additional subnets may be candidates for further discovery procedures. Thus, discovery may progress iteratively or recursively.

Once discovery completes, a snapshot representation of each discovered device, application, and service is available in CMDB **500**. For example, after discovery, operating system version, hardware configuration, and network configuration details for client devices, server devices, and routers in managed network **300**, as well as applications executing thereon, may be stored. This collected information may be presented to a user in various ways to allow the user to view the hardware composition and operational status of devices, as well as the characteristics of services that span multiple devices and applications.

Furthermore, CMDB **500** may include entries regarding dependencies and relationships between configuration items. More specifically, an application that is executing on a particular server device, as well as the services that rely on this application, may be represented as such in CMDB **500**. For example, suppose that a database application is executing on a server device, and that this database application is used by a new employee onboarding service as well as a payroll service. Thus, if the server device is taken out of operation for maintenance, it is clear that the employee onboarding service and payroll service will be impacted. Likewise, the dependencies and relationships between configuration items may be able to represent the services impacted when a particular router fails.

In general, dependencies and relationships between configuration items may be displayed on a web-based interface and represented in a hierarchical fashion. Thus, adding, changing, or removing such dependencies and relationships may be accomplished by way of this interface.

Furthermore, users from managed network **300** may develop workflows that allow certain coordinated activities to take place across multiple discovered devices. For

instance, an IT workflow might allow the user to change the common administrator password to all discovered LINUX® devices in a single operation.

In order for discovery to take place in the manner described above, proxy servers **312**, CMDB **500**, and/or one or more credential stores may be configured with credentials for one or more of the devices to be discovered. Credentials may include any type of information needed in order to access the devices. These may include userid/password pairs, certificates, and so on. In some embodiments, these credentials may be stored in encrypted fields of CMDB **500**. Proxy servers **312** may contain the decryption key for the credentials so that proxy servers **312** can use these credentials to log on to or otherwise access devices being discovered.

The discovery process is depicted as a flow chart in FIG. **5B**. At block **520**, the task list in the computational instance is populated, for instance, with a range of IP addresses. At block **522**, the scanning phase takes place. Thus, the proxy servers probe the IP addresses for devices using these IP addresses, and attempt to determine the operating systems that are executing on these devices. At block **524**, the classification phase takes place. The proxy servers attempt to determine the operating system version of the discovered devices. At block **526**, the identification phase takes place. The proxy servers attempt to determine the hardware and/or software configuration of the discovered devices. At block **528**, the exploration phase takes place. The proxy servers attempt to determine the operational state and applications executing on the discovered devices. At block **530**, further editing of the configuration items representing the discovered devices and applications may take place. This editing may be automated and/or manual in nature.

The blocks represented in FIG. **5B** are examples. Discovery may be a highly configurable procedure that can have more or fewer phases, and the operations of each phase may vary. In some cases, one or more phases may be customized, or may otherwise deviate from the exemplary descriptions above.

In this manner, a remote network management platform may discover and inventory the hardware, software, and services deployed on and provided by the managed network. As noted above, this data may be stored in a CMDB of the associated computational instance as configuration items. For example, individual hardware components (e.g., computing devices, virtual servers, databases, routers, etc.) may be represented as hardware configuration items, while the applications installed and/or executing thereon may be represented as software configuration items.

The relationship between a software configuration item installed or executing on a hardware configuration item may take various forms, such as “is hosted on”, “runs on”, or “depends on”. Thus, a database application installed on a server device may have the relationship “is hosted on” with the server device to indicate that the database application is hosted on the server device. In some embodiments, the server device may have a reciprocal relationship of “used by” with the database application to indicate that the server device is used by the database application. These relationships may be automatically found using the discovery procedures described above, though it is possible to manually set relationships as well.

The relationship between a service and one or more software configuration items may also take various forms. As an example, a web service may include a web server software configuration item and a database application software configuration item, each installed on different hard-

ware configuration items. The web service may have a “depends on” relationship with both of these software configuration items, while the software configuration items have a “used by” reciprocal relationship with the web service. Services might not be able to be fully determined by discovery procedures, and instead may rely on service mapping (e.g., probing configuration files and/or carrying out network traffic analysis to determine service level relationships between configuration items) and possibly some extent of manual configuration.

Regardless of how relationship information is obtained, it can be valuable for the operation of a managed network. Notably, IT personnel can quickly determine where certain software applications are deployed, and what configuration items make up a service. This allows for rapid pinpointing of root causes of service outages or degradation. For example, if two different services are suffering from slow response times, the CMDB can be queried (perhaps among other activities) to determine that the root cause is a database application that is used by both services having high processor utilization. Thus, IT personnel can address the database application rather than waste time considering the health and performance of other configuration items that make up the services.

## V. SYSTEMS AND METHODS FOR SOFTWARE LICENSE MANAGEMENT

Managed network **300** may use the computing devices described above in relation to FIGS. **1** and **2** to facilitate and manage its many interrelated operations. In turn, the computing devices may rely on software applications to perform tasks. Each computing device may be tasked with performing a set of operations, and accordingly may use a combination of software applications to perform those tasks. While some such software applications may be hosted by remote network management platform **320**, others may be installed on the individual computing devices themselves. Such software is often proprietary, and may be licensed in several ways.

By way of example, a software license may include “per-device” license rights, which may specify a number of computing/server devices that are permitted to use the software. As another example, computing devices may include various physical processors, and a software license may include “per-processor” license rights, which may specify a number of physical processors having permission to use the software. Other examples are also possible.

In addition, each software license may specify costs related to use of software. For example, with regard to per-device license rights, a software license may specify a licensing cost per device that uses the software (e.g., a cost of \$1,200 for each computing device that has the software installed thereon). In other examples, a software license may have a more complex costs arrangement, as the cost per device, processor, and/or core may vary depending on the number of device, processors and/or cores using the software (e.g., a cost of \$500 per processor for the first ten processors that have the software installed thereon and a cost of \$450 per processor for the next ten processors that have the software installed thereon, and so on). Other licensing schemes are possible as well.

Regardless of the scheme, managed network **300** may attempt to keep track of which of its computing devices, physical processors, and/or processor cores use what licensed software. In so doing, managed network **300** may determine whether it is in compliance with its various



software licenses, whether it is using its licensed software efficiently, and/or whether it should purchase new software licenses.

Remote network management platform **320** may be particularly suited to track such software usage because it is already configured to gather information from computing devices in managed network **300**. Specifically, tracking the use of software within managed network **300** may involve determining configuration items in the manner described above in relation to FIGS. **5A** through **5B**. For example, during identification phase **526** of discovery, computational instance **322** of remote network management platform **320** may determine the configuration of discovered devices, including identification parameters indicative of specific computing devices. Further, during exploration phase **528**, computational instance **322** may determine services, such as software applications, of each discovered device. The identification parameters associated with such software applications may indicate on which specific computing device(s) each software application is installed. The identification parameters may additionally or alternatively specify a number of processors or cores of a computing device, a device name, or a named user, associated with each software application. As such, depending on the licensing scheme, the remote network management platform **320** could count software installations per-device, per-processor, or per-core, among other options.

Further, remote network management platform **320** could determine to what extent managed network **300** is in compliance with its software licenses. For example, remote network management platform **320** may run discovery on computing devices within managed network **300** to determine how many times each software application has been installed as discussed (e.g., how many times each software application is installed on devices within managed network **300**). In some cases, remote network management platform **320** may also determine how many users from managed network **300** access each installed software application. Then, remote network management platform **320** may compare the number of software installations with the software license rights to determine whether the software application(s) are in or out of compliance.

To facilitate this process, remote network management platform **320** could provide for establishment of software configurations (sometimes referred to as “software models”). A given software configuration could track license rights allocations and usage associated with a particular software application. Remote network management platform **320** could use the software configuration to determine whether license rights usage for a particular software application complies with the license rights allocations for the particular software application. Thus, software configurations could help an enterprise figure out whether usage of software applications complies with licenses associated with the software applications.

Remote network management platform **320** could provide for establishment of software configurations in various ways. For example, remote network management platform **320** may provide, to a client device, a representation of a graphical user interface (GUI) that includes feature(s) for establishing software configuration(s). Through this GUI, a user of the client device may provide input to specify identifying information (e.g., a respective publisher, title, version, and/or edition) and license right allocations for a given software application, so as to establish an initial software configuration for the given software application. Then, remote network management platform **320** could

update the initial software configuration to specify an installation count for the given software application according to the above-mentioned discovery, thereby causing the updated software configuration to indicate a license rights usage for the given software application.

In some embodiments, remote network management platform **320** may automatically generate software configurations. To enable this, remote network management platform **320** may store attributes for one or more software configurations in CMDB **500** (or perhaps another database). Attributes for a software configuration may include the particular publisher, title, version, and/or edition of the software configuration. During discovery, remote network management platform **320** may determine whether any of the stored software configurations respective attributes match discovered attributes associated with a particular software application. If all attributes of a particular stored software configuration match, then remote network management platform **320** may use the particular stored software configuration as an initial software configuration for the particular software application.

If none of the stored software configurations have matching attributes, then remote network management platform **320** may generate a new software configuration the particular software application. This process may involve (i) gathering attributes (e.g., a particular publisher, title, version, and/or edition) for the particular software configuration via a GUI and updating the CMDB **500** to include the gathered attributes associated with the new software configuration.

Once determining an extent to which managed network **300** is in compliance with its software licenses, the remote network management platform **320** may perform an action based on this determined extent. For example, remote network management platform **320** may provide, via a GUI, a recommendation to purchase additional licenses, to install a software application on more devices, or to uninstall the software application from certain computing devices within managed network **300**. In some examples, remote network management platform **320**, upon determination that certain criteria have been met, may automatically purchase additional software licenses, or reorganize which devices, processors, or cores upon which the software applications are installed. Various other examples are also possible.

Although establishment of software configurations can help managed network **300** track software license compliance, various problematic situations could still arise. In particular, managed network **300** may utilize some software applications subject to concurrent license agreements. Such agreements generally provide a pool of licenses that can be “checked-in” and “checked-out” by users from managed network **300**. More specifically, when a user wishes to run a software application subject to a concurrent license agreement, the user requests a license from a central licensing server located on managed network **300**. If a license is available from the pool, the central licensing server allows the application to run. When the user is finished using the application, or when an allowed license period expires, the license is reclaimed by the central licensing server and made available to other users. Common software applications subject to concurrent license agreement include AUTO-CAD® and ARCGIS®. Note that for the purposes of brevity, software applications subject to a concurrent license agreement may be referred to herein as “concurrent software applications” and software licenses associated with software applications subject to a concurrent license agreement may be referred to herein “concurrent licenses”.

By design, concurrent software agreements decouple the installation of a concurrent software application from the license required to run the concurrent software application. For example, managed network **300** may have AUTOCAD® installed on 500 computing devices, but may only have licenses rights allocations for 150 AUTOCAD® licenses. Such an arrangement would be entirely compliant in a concurrent software agreement, as long as the number of licenses of AUTOCAD® that are checked out at a given time does not exceed 150. Yet this arrangement may cause difficulties for remote network management platform **320**, which generally expects a one to one relationship between licenses and software applications installed in managed network **300**. For example, in the scenario above, remote network management platform **320** may determine that managed network **300** is out of compliance because the number of installations of AUTOCAD® exceeds the number of license rights allocations. But this determination would be erroneous. Further, because remote network management platform **320** is unable determine when a concurrent license is checked out of/checked into a central licensing server, the remote network management platform **320** may provide managed network **300** with an inaccurate representation of actual license usage. Other issues with managing concurrent licenses are also possible.

The present description discloses embodiments to address these and other issues. In particular, the systems and methods herein integrate remote network management platform **320** with one or more central licensing servers that respectively manage a pool of concurrent licenses on behalf of managed network **300**. Through this integration, remote network management platform **320** may accurately determine usage statistics and perhaps other information about concurrent licenses on managed network **300**. In some cases, the integration is facilitated through a 3<sup>rd</sup> party consolidation server. Using the information received from the one or more licensing servers, remote network management platform **320** could update software configurations to specify usage counts for concurrent software applications. Then, remote network management platform **320** could provide, via a GUI, a recommendation to purchase additional licenses, to reduce underutilized licenses, and so on. Advantageously, the embodiments herein enable remote network management platform **320** to provide accurate information about concurrent licenses usage to managed network **300**. Other advantages are also possible and may be understood from the disclosure herein.

FIG. 6 illustrates network architecture **600**, in accordance with example embodiments. Network architecture **600** may facilitate the discovery and management of concurrent licenses. Network architecture **600** includes managed network **300** and computational instance **322**, which are perhaps connected by way of Internet **350** (not shown).

Managed network **300** includes entities **602**, licensing server **604**, licensing server **606**, and license consolidation server **608**. Managed network **300** may also include other devices and software applications as described above, but these are omitted from FIG. 6 for purposes of simplicity.

Entities **602** can include, but are not limited to, one or more devices, computer processors, and/or computer processor cores disposed on managed network **300**. Entities **602** may have installed thereon concurrent software applications, but may be unable to run the applications without first checking out a concurrent license from licensing server **604/606**.

Licensing servers **604** and **606** may include various devices and software services that manage and distribute

concurrent licenses. In particular, licensing servers **604/606** may maintain a pool (e.g., one or more) of concurrent licenses. Licensing servers **604/606** distribute concurrent licenses from the pool to entities **602** so that entities **602** can run concurrent software applications. The size of the pool may depend on license rights allocated to managed network **300**. In some embodiments, licensing servers **604/606** each manage concurrent licenses for a single concurrent software application. For example, licensing server **604** may manage concurrent licenses for AUTOCAD® and licensing server **606** may manage concurrent licenses for ARCGIS®. In some embodiments, licensing servers **604/606** manage concurrent licenses for a plurality of concurrent software applications. For example, licensing server **604** may manage concurrent licenses for AUTOCAD® and ARCGIS®.

When entities **602** wish to run a concurrent software application C\_SA\_A, they send a check-out request to licensing servers **604/606**. In response, licensing servers **604/606** may perform the following “check-out” operations:

- (1) GET NUM\_AVAILABLE\_LICENSES for CSA\_A from memory.
- (2) If NUM\_AVAILABLE\_LICENSES<1, return NONE to entities **602**.
- (3) Else: decrement NUM\_AVAILABLE\_LICENSES, get available license LICENSE\_A for CSA\_A from memory, and return LICENSE\_A to entities **602**.
- (4) Set allowed license period (TTL\_A) for LICENSE\_A=X, set the LICENSE\_A=UNAVAILABLE.

When entities **602** are done using concurrent software application CSA\_A, or when the allowed license period TTL\_A expires, they send a check-in request to licensing servers **604/606**. In response, licensing servers **604/606** may perform the following “check-in” operations:

- (1) RECEIVE check-in request from entities **602** for LICENSE\_A
- (2) SET LICENSE\_A=AVAILABLE
- (3) increment NUM\_AVAILABLE\_LICENSE for CSA\_A.

These “check-out”/“check-in” operations allow licensing servers **604/606** to properly maintain and distribute a pool of concurrent licenses to entities **602**. Licensing servers **604/606** may also track these operations for later analysis. For example, licensing servers **604/606** can monitor and persist a current value of NUM\_AVAILABLE\_LICENSE, the number of times NONE is returned to entities **602**, and a current value of LICENSE\_A, among other possibilities. These tracked operations may be referred to herein as concurrent license usage statistics.

License consolidation server **608** may include devices and applications that collect concurrent license usage statistics from licensing servers **604/606**. More particularly, license consolidation server **608** acts as an aggregation server for all licensing servers disposed in managed network **300**. Statistics obtained by license consolidation server **608** from licensing servers **604/606** may include, but are not limited to, the number of available licenses for a concurrent software application (e.g., the value of NUM\_AVAILABLE\_LICENSE), whether a particular concurrent license is currently available (e.g., the value of LICENSE\_A), and so on.

To obtain statistics from licensing servers **604/606**, license consolidation server **608** may use software agent **608A** and software agent **608B**. As used herein, a software agent refers to a software application associated with license consolidation server **608**, but operating on a licensing server within managed network **300**. Managed network **300** may respectively install software agents **608A/608B** onto licensing servers **604/606** on behalf of license consolidation server **608**. Upon installation, software agents **608A/608B** may be

granted root privileges to licensing servers **604/606**. That is, software agents **608A/608B** can read, modify and execute programs/files/directories on licensing servers **604/606**. Software agents **608A/608B** can leverage these root privileges to obtain statistics from licensing servers **604/606**. For example, software agents **608A/608B** may operate to read log files and intercept packet data related to the “check-out”/“check-in” operations described above. Then, software agents **608A/608B** may transmit this data to license consolidation server **608**.

Cloud-based license consolidation server **610** may be operated by the same entity that operates license consolidation sever **608**. In examples, cloud-based license consolidation server **610** may provide the same services as license consolidation server **608**, but in a cloud based environment physically separate from managed network **300**.

Both license consolidation server **608** and cloud-based license consolidation server **610** may provide an application programming interface (API) for querying concurrent license usage statistics aggregated from licensing servers on managed network **300**. This API may be a representational state transfer (REST) API using HTTP, for instance, but other types of APIs may be used. As an example, given that license consolidation server **608**/cloud-based license consolidation server **610** are operated by OPENLM®, a request URL to retrieve information about currently used concurrent software licenses may take on the following form: “http://[openlm server]:7020/OpenLM. Server. Services/AdminAPI/CurrentlyConsumedLicenses”, where [openlm server] is an IP address for license consolidation server **608** on managed network **300**. The OPENLM® example above is for purposes of illustration and not limiting. Other query formats and APIs may exist.

Network architecture **600** also contains computational instance **322**, which includes CMDB **500**. As described above, computational instance **322** may be part of remote network management platform **320** and may include various devices and software services used to remotely administer aspects of managed network **300**.

As shown by the dotted lines in FIG. **6**, computational instance **322** may execute a remote access call on license consolidation server **608**/cloud-based license consolidation server **610**. Generally speaking, a remote access call is a series of operations that instruct a software application to access data from another software application/computational entity. In some cases, remote access calls may involve an API call. For example, a remote access call may specify what credentials to use to access license consolidation server **608**/cloud-based license consolidation server **610**, what data therein to obtain (e.g., which API endpoints to query), and what tables in CMDB **500** to populate with the obtained data. Executing a remote access call may also be referred to as “remotely accessing”.

FIG. **7** depicts message flow **700**, in accordance with example embodiments. In message flow **700**, computational instance **322** can initialize a software configuration and then update the software configuration with statistics received from license consolidation server **608**. By way of example, message flow **700** may utilize computational instance **322** and managed network **300** during operation. However, additional components, steps, or blocks, may be added to message flow **700**. Also note that while the message flow **700** may utilize license consolidation server **608**, the steps below may be similarly applied to cloud-based license consolidation server **610**.

At step **702**, computational instance **322** provides a GUI to a user from managed network **300**. The GUI may include

feature(s) for establishing software configuration(s). The user from managed network **300** may provide input into the GUI to specify identifying information (e.g., a respective publisher, title, version, and/or edition) and license right allocations for a given concurrent software application. In some cases, step **702** may be prompted by the user from managed network **300**, for example, by requesting the GUI from computational instance **322**. At step **704**, computational instance **322** receives the input from the GUI and establishes an initial software configuration for the given concurrent software application.

At steps **706** and **708**, computational instance **322** executes a remote access call to obtain usage statistics for one or more licensing servers disposed on managed network **300**. This is facilitated by way of license consolidation server **608**. In particular, the remote access call may operate to query one or more REST APIs of license consolidation server **608**, specifying authentication credentials and other parameters to determine the concurrent license usage statistics. In response, license consolidation server **608** may provide concurrent license statistics specified by the query. Notably, since license consolidation server **608** may represent one out of many license consolidation servers used by manage network **300**, the process of steps **706** and **708** may repeat for any number of different license consolidation servers.

At step **710**, computational instance **322** updates the initial software configuration with the concurrent license statistics ascertained in steps **706** and **708**.

At step **712**, computational instance **322** provides a representation of an updated graphical interface to the user from managed network **300**. The updated interface may contain information related to the updated software configuration, including, but not limited to, recommendations to purchase additional licenses, to reduce underutilized licenses, and so on. The recommendations may be established by comparing the concurrent license statistics discovered in steps **706/708** to the license right allocations entered in step **702**. Examples of graphical interfaces are presented below. In some embodiments, steps **702** and **712** may alternatively involve the user requesting and receiving the representation of the updated graphical interface from computational instance **322**.

## VI. EXAMPLE GRAPHICAL INTERFACES

As described herein, the term “pane” may refer to a GUI component that contains one or more locations in which to display information, and/or one or more user-selectable items such as buttons or tabs. In some embodiments, a pane may be equivalent to, or contained within, a page or a GUI window, though such a window may contain multiple panes. Buttons and/or tabs may be graphical control elements that display additional information within the pane. The GUIs and/or panes described herein may be provided to users at step **712** of message flow **700** or when they access a computational instance on a remote network management platform, such as computational instance **322** within remote network management platform **320** as described in FIG. **3**.

As previously discussed, management of software licenses can be a complex task. The may be especially so with concurrent licenses that can be checked out/checked in by users at various times, for various lengths of time, and so on. The GUIs herein address these issues by way of a series of panes that enable efficient review of pertinent information about concurrent license usage within managed network **300**. The example panes shown in FIGS. **8A**, **8B**, **8C**, and **8D** may organize and arrange the information for concurrent

licenses using graphics with intuitive visuals and easy to understand metrics. As a result, concurrent licenses can be more effectively managed, resulting in a maximum cost savings for managed network **300**.

FIG. **8A** depicts overview pane **810**, in accordance with example embodiments. Overview pane includes summary **812**, top used products graph **814**, top denied product graph **816**, and license utilization graph **818**. Overview pane also includes navigation bar **802**, which includes tabs for “Overview”, “License Usage Summary”, “Denials Summary”, and “Product Use Summary”. Notably, the tab for “Overview” is shown in a dark color background to indicate that this tab’s information is currently displayed.

Summary **812** depicts summarized information on the total spent and the potential savings with respect to managed network **300**. The total spent may relate to the total amount spent by managed network **300** on the concurrent licenses, while the potential savings may relate to the total amount that managed network **300** could save on concurrent licenses. Computational instance **322** may determine these metrics by comparing license rights allocations to concurrent license usage statistics. As an example, managed network **300** may have purchased **150** licenses for a given concurrent software application, but usage statistics from license manager server **608** may indicate that only **100** licenses for the given concurrent software application are typically used. Accordingly, managed network **300** can potentially save on **50** licenses. As shown in FIG. **8A**, the total amount spent for all concurrent licenses is **\$103,000** and the potential savings is **\$43,000**.

Top used products graph **814** summarizes usage counts for one or more concurrent software applications (referred to in the Figures as “products”). As used herein, a usage count refers to the total amount of “check-outs” for a given concurrent software application. As shown, product **2** is shown to have the highest usage rate, followed by product **4**, then product **5**, then product **3**, and finally product **1**. To determine usage rates, remote network management platform **320** may query license consolidation server **608**/cloud-based license consolidation server **610** for information on which concurrent software applications are checked out the most frequently.

Top denied products graph **816** summarizes denial counts for one or more concurrent software applications. As referred to herein, a denial count refers to a situation when a user wishes to check out a concurrent license from a pool, but cannot because the pool does not have any available licenses to distribute. FIG. **8A** shows that product **5** has the highest denial count, followed by product **3**, then product **2**, then product **4**, and finally product **1**. To determine denial counts, remote network management platform **320** may query license consolidation server **608**/cloud-based license consolidation server **610** for information on how many times a concurrent software application has been denied.

License utilization graph **818** summarizes the utilization of one or more concurrent software applications. A utilization for a given concurrent software application is determined by comparing usage counts for the given application to the number of license right allocations (e.g., “available” licenses) for the given application. FIG. **8A** shows that product **2** has the highest utilization, followed by product **3**, then product **4**, then product **5**, and finally product **1**.

FIG. **8B** depicts license usage summary pane **820**, in accordance with example embodiments. License usage summary pane **820** includes usage graph **822**, active users table **824**, idle users table **826**, and denied users table **828**. Like overview pane **810**, license usage summary pane **820** also

includes navigation bar **802**, which includes tabs for “Overview”, “License Usage Summary”, “Denials Summary”, and “Product Use Summary”. Notably, the tab for “License Usage Summary” is shown in a dark color background to indicate that this tab’s information is currently displayed.

Usage graph **822** displays a data plot of usage counts and license right allocations over some period of time. As shown in FIG. **8B**, the number of rights owned and rights used for a given concurrent software application varied over time. Particularly, in Days 1-3 there was an under-utilization of licenses, at Day 4 utilization was at its peak, and then in Days 5-7 there again was an under-utilization of licenses. Graph **822** may be beneficial as it allows a user to see the utilization of a concurrent software application over time, which may help the user choose an appropriate remediation action.

Active users table **824** may be a detailed list-view of active users on managed network **300**. As used herein, an active user refers to a user from managed network **300** that checks out a concurrent license and proceeds to actively use (e.g., run process or perform operations with) the concurrent software application associated with the checked out license. It may be advantageous for remote network management platform **320** to track active users because they genuinely use the checked out license. Each row in active users table **824** may include details related to an active user, including (i) the active user’s ID, (ii) the number of sessions for the active user, and (iii) the total duration of all the sessions for that user. As referred to herein, a session refers to the period of time from when a user checks out a concurrent license to when the user checks in the concurrent license.

Idle users table **826** may be a detailed list-view of idle users on managed network **300**. As used herein, an idle user refers to a user from managed network **300** that checks out a concurrent license and does not actively use (e.g., does not run process or perform operations with) the concurrent software application associated with the checked out license. It may be advantageous for remote network management platform **320** to track idle users because they do not genuinely use the checked out license, thereby wasting the license. Each row in active users table **824** may include details related to an idle user, including (i) the idle user’s ID, (ii) an ID of a computing device associated with the idle user, and (iii) the total duration of the idle session for that user.

In some embodiments, idle users may include users who check out a concurrent license and then minimally use the concurrent software application associated with the checked out license. For example, a user may check out a concurrent license for ten hours, but may only use the concurrent software application associated with the checked out license for a few minutes. The definition for minimal use may be dynamically configured by users from managed network **300**. As an example, minimal use may be defined as any user who checks out a concurrent license for X hours and then uses the concurrent software application associated with the checked out license for 0.2X hours or less. Other definitions are also possible.

Denied users table **828** may be a detailed list-view of denied users on managed network **300**. The idea here is that it may be advantageous for remote network management platform **320** to track denied users as this helps determine if additional licenses should be purchased. Each row in denied users table **828** may include details related to a denied user, including (i) the denied user’s ID, (ii) an ID of a computing device associated with the denied user, and (iii) the total number of denials for the denied user.

FIG. 8C depicts denials summary pane **830**, in accordance with example embodiments. Denials summary pane **830** includes denials graph **832**, denials by application chart **834**, denials by project chart **836**, and denials by user group chart **838**. Like the previous panes, denials summary pane **830** also includes navigation bar **802**, which includes tabs for “Overview”, “License Usage Summary”, “Denials Summary”, and “Product Use Summary”. Notably, the tab for “Denials Summary” is shown in a dark color background to indicate that this tab’s information is currently displayed.

Denials graph **832** is a line graph depicting the total denials number of denials for a given day, with the number of denials on the y-axis and the day on the x-axis.

Denials by application chart **834** is a pie chart depicting the total denials per concurrent software application. As shown, product **2** has the highest proportion of denials, followed by product **5**, then product **1**, then product **3**, and finally product **4**.

Denials by project chart **836** is a pie chart depicting the total denials per project. As referred to herein, a project is a grouping of concurrent software applications that are used in unison to achieve a predefined goal. A project may include, for example, a “Engineering Project”, which uses both AUTOCAD® and ARCGIS® to achieve a goal. The idea here is that it may be advantageous for remote network management platform **320** to track which projects are suffering from the most denials. As shown, project **2** has the highest proportion of denials, followed by projects **3** and **4**, then project **5**, and finally project **1**.

Denials by user group chart **838** is a pie chart depicting the total denials per a user group. As referred to herein, a user group is a set of users on managed network **300** that belong to the same organizational entity. User groups may include, for example, the “Finance Team”, the “HR Team”, or the “IT Team”. The idea here is that it may be advantageous for remote network management platform **320** to track which user groups are getting denied the most. As shown, user group **5** has the highest proportion of denials, followed by user group **1**, then user group **3**, then user group **2**, and finally user group **4**.

FIG. 8D depicts product use summary pane **840**, in accordance with example embodiments. Product use summary pane **840** includes product usage by group chart **842** and product usage by project chart **844**. Like the previous panes, denials summary pane **840** also includes navigation bar **802**, which includes tabs for “Overview”, “License Usage Summary”, “Denials Summary”, and “Product Use Summary”. Notably, the tab for “Product Use Summary” is shown in a dark color background to indicate that this tab’s information is currently displayed.

Product usage by group chart **842** is a pie chart depicting total product usage for a particular user group on managed network **300**. As shown, product **2** has the highest proportion of usage in the particular user group, followed by product **5**, then product **1**, then product **3**, and finally product **4**.

Product usage by project chart **844** is a pie chart depicting total product usage for a particular project on managed network **300**. As shown, products **5** and **1** have the highest proportion of usage in the particular project, followed by product **3**, and finally products **2** and **4**.

Note that the panes above are presented merely for purposes of illustration and are not intended to be limiting. Other panes and/or web pages including alternative arrangements of information may also exist.

## VII. EXAMPLE OPERATIONS

FIG. 9 is a flow chart illustrating an example embodiment. The process illustrated by FIG. 9 may be carried out by a

computing device, such as computing device **100**, and/or a cluster of computing devices, such as server cluster **200**. However, the process can be carried out by other types of devices or device subsystems. For example, the process could be carried out by a portable computer, such as a laptop or a tablet device.

The embodiments of FIG. 9 may be simplified by the removal of any one or more of the features shown therein. Further, these embodiments may be combined with features, aspects, and/or implementations of any of the previous figures or otherwise described herein.

Block **900** involves remotely accessing a license consolidation server using access credentials thereof, where license consolidation server acquires and stores concurrent license usage statistics for a concurrent software application by obtaining license usage data from at least one licensing server disposed on a managed network, where a computational instance of a remote network management platform is dedicated to the managed network, where the computational instance includes persistent storage.

Block **910** involves, while remotely accessing the license consolidation server, obtaining the concurrent license usage statistics from the license consolidation server.

Block **920** involves, in response to obtaining the concurrent license usage statistics, updating a software configuration with the concurrent license usage statistics, where the software configuration is stored in the persistent storage and contains a license rights allocation for the concurrent software application.

Block **930** involves, based on the concurrent license usage statistics and the license rights allocation, generating a representation of a graphical user interface that contains an overview pane that indicates a utilization of the concurrent software application.

Block **940** involves transmitting, to a client device associated with the managed network, the representation of the graphical user interface.

In some embodiments, the license consolidation server provides second concurrent license usage statistics for a second concurrent software application by obtaining license usage data from at least one licensing server disposed on the managed network. The embodiments may also involve, while remotely accessing the license consolidation server, obtaining the second concurrent license usage statistics from the license consolidation server. The embodiments may also involve, in response to obtaining the second concurrent license usage statistics, updating a second software configuration with the second concurrent license usage statistics, where the second software configuration is stored in the persistent storage, where the second software configuration contains a second license rights allocation for the second concurrent software application, and where the overview pane of the graphical user interface further indicates a second utilization of the second concurrent software application.

Some embodiments involve remotely accessing a second license consolidation server using access credentials thereof, where the second license consolidation server provides second concurrent license usage statistics for a second concurrent software application by obtaining license usage data from at least one licensing server disposed on the managed network. The embodiments may also involve while remotely accessing the second license consolidation server, obtaining the second concurrent license usage statistics from the second license consolidation server. The embodiments may also involve upon obtaining the second concurrent license usage statistics, updating a second soft-

ware configuration with the second concurrent license usage statistics, where the second software configuration is stored in the persistent storage, where the second software configuration contains a second license rights allocation for the second concurrent software application, and where the overview pane of the graphical user interface further indicates a second utilization of the second concurrent software application.

In some embodiments, the license consolidation server is disposed in the managed network.

In some embodiments, the license consolidation server is disposed in a remote cloud-based environment distinctly separate from the managed network.

In some embodiments, the computational instance and the license consolidation server are operated by different entities.

In some embodiments, the license consolidation server obtains the license usage data by way of one or more software agents installed onto the at least one licensing server disposed on the managed network.

In some embodiments, the representation of the graphical user interface further contains a number of denials for the concurrent software application.

In some embodiments, the representation of the graphical user interface further contains a list-based view for active users on the managed network, where the list-based view specifies in line items that include: (i) a user ID, (ii) a computing device associated with the user ID, and (iii) a total duration of an active session for a user associated with the user ID.

In some embodiments, the representation of the graphical user interface further contains a list-based view for idle users on the managed network, where the list-based view specifies in line items that include: (i) a user ID, (ii) a computing device associated with the user ID, and (iii) a total duration of an idle session for a user associated with the user ID.

In some embodiments, the representation of the graphical user interface further contains a list-based view for denied users on the managed network, where the list-based view specifies in line items that include: (i) a user ID, (ii) a computing device associated with the user ID, and (iii) a total number of denials for a user associated with the user ID.

In some embodiments, the representation of the graphical user interface further includes a graph-based view that display: (i) a number of available concurrent licenses plotted over time, and (ii) a usage count of concurrent licenses plotted over time.

In some embodiments, the representation of the graphical user interface further includes pie charts that display: (i) a total number of denials per concurrent software application, (ii) a total number of denials per user group, and (iii) a total number of denials per project.

## VIII. CONCLUSION

The present disclosure is not to be limited in terms of the particular embodiments described in this application, which are intended as illustrations of various aspects. Many modifications and variations can be made without departing from its scope, as will be apparent to those skilled in the art. Functionally equivalent methods and apparatuses within the scope of the disclosure, in addition to those described herein, will be apparent to those skilled in the art from the foregoing descriptions. Such modifications and variations are intended to fall within the scope of the appended claims.

The above detailed description describes various features and operations of the disclosed systems, devices, and methods with reference to the accompanying figures. The example embodiments described herein and in the figures are not meant to be limiting. Other embodiments can be utilized, and other changes can be made, without departing from the scope of the subject matter presented herein. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the figures, can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations.

With respect to any or all of the message flow diagrams, scenarios, and flow charts in the figures and as discussed herein, each step, block, and/or communication can represent a processing of information and/or a transmission of information in accordance with example embodiments. Alternative embodiments are included within the scope of these example embodiments. In these alternative embodiments, for example, operations described as steps, blocks, transmissions, communications, requests, responses, and/or messages can be executed out of order from that shown or discussed, including substantially concurrently or in reverse order, depending on the functionality involved. Further, more or fewer blocks and/or operations can be used with any of the message flow diagrams, scenarios, and flow charts discussed herein, and these message flow diagrams, scenarios, and flow charts can be combined with one another, in part or in whole.

A step or block that represents a processing of information can correspond to circuitry that can be configured to perform the specific logical functions of a herein-described method or technique. Alternatively or additionally, a step or block that represents a processing of information can correspond to a module, a segment, or a portion of program code (including related data). The program code can include one or more instructions executable by a processor for implementing specific logical operations or actions in the method or technique. The program code and/or related data can be stored on any type of computer readable medium such as a storage device including RAM, a disk drive, a solid state drive, or another storage medium.

The computer readable medium can also include non-transitory computer readable media such as computer readable media that store data for short periods of time like register memory and processor cache. The computer readable media can further include non-transitory computer readable media that store program code and/or data for longer periods of time. Thus, the computer readable media may include secondary or persistent long term storage, like ROM, optical or magnetic disks, solid state drives, or compact-disc read only memory (CD-ROM), for example. The computer readable media can also be any other volatile or non-volatile storage systems. A computer readable medium can be considered a computer readable storage medium, for example, or a tangible storage device.

Moreover, a step or block that represents one or more information transmissions can correspond to information transmissions between software and/or hardware modules in the same physical device. However, other information transmissions can be between software modules and/or hardware modules in different physical devices.

The particular arrangements shown in the figures should not be viewed as limiting. It should be understood that other embodiments can include more or less of each element shown in a given figure. Further, some of the illustrated

elements can be combined or omitted. Yet further, an example embodiment can include elements that are not illustrated in the figures.

While various aspects and embodiments have been disclosed herein, other aspects and embodiments will be apparent to those skilled in the art. The various aspects and embodiments disclosed herein are for purpose of illustration and are not intended to be limiting, with the true scope being indicated by the following claims.

What is claimed is:

1. A system, comprising:  
one or more hardware processors; and  
a non-transitory memory storing instructions that, when executed by the one or more hardware processors, cause the one or more hardware processors to perform actions comprising:  
obtaining concurrent license usage statistics for a software application from a license consolidation server by remotely accessing the license consolidation server;  
in response to obtaining the concurrent license usage statistics, updating a software configuration based on the concurrent license usage statistics, wherein the software configuration comprises a license rights allocation for the software application; and  
based on the concurrent license usage statistics and the license rights allocation, generating a representation of a graphical user interface (GUI) that includes an indication of a utilization of the software application.
2. The system of claim 1, wherein obtaining the concurrent license usage statistics for the software application from the license consolidation server comprises executing a remote access call to the license consolidation server, and wherein the remote access call specifies credentials to remotely access the license consolidation server and an identification of the concurrent license usage statistics to be obtained from the license consolidation server.
3. The system of claim 2, wherein the remote access call is to a representational state transfer (REST) application programming interface (API) of the license consolidation server.
4. The system of claim 1, wherein updating the software configuration comprises updating one or more tables of a configuration management database (CMDB) with the concurrent license usage statistics.
5. The system of claim 4, wherein the actions comprise: receiving an input indicative of an initial configuration of the software configuration; and storing the initial configuration of the software configuration in the one or more tables of the CMDB.
6. The system of claim 1, wherein the representation of the GUI includes an indication of active users of the software application, idle users of the software application, or denied users of the software application, or any combination thereof.
7. The system of claim 1, wherein the actions comprise: determining an extent of compliance with the license rights allocation based on the concurrent license usage statistics; and generating a representation of an additional GUI that provides a recommendation to purchase one or more licenses, install the software application on one or more devices, or to uninstall the software application from one or more other devices, or any combination thereof, based on the extent of compliance with the license rights allocation.

8. The system of claim 7, wherein the actions comprise determining a first financial amount spent on the license rights allocation and a second financial amount of potential financial savings based on the recommendation, and wherein the representation of the additional GUI includes indications of the first financial amount and the second financial amount.

9. The system of claim 1, wherein the representation of the GUI includes indications of a number of available licenses for the software application plotted over time, or a usage count of licenses for the software application plotted over time, or both.

10. A method, comprising:

obtaining concurrent license usage statistics for a software application from a license consolidation server by remotely accessing the license consolidation server;  
in response to obtaining the concurrent license usage statistics, updating a software configuration based on the concurrent license usage statistics, wherein the software configuration comprises a license rights allocation for the software application; and  
based on the concurrent license usage statistics and the license rights allocation, generating a representation of a graphical user interface (GUI) that includes an indication of a utilization of the software application.

11. The method of claim 10, wherein obtaining the concurrent license usage statistics for the software application from the license consolidation server comprises executing a remote access call to the license consolidation server, and wherein the remote access call specifies credentials to remotely access the license consolidation server and an identification of the concurrent license usage statistics to be obtained from the license consolidation server.

12. The method of claim 10, wherein updating the software configuration comprises updating one or more tables of a configuration management database (CMDB) with the concurrent license usage statistics.

13. The method of claim 12, comprising:

receiving an input indicative of an initial configuration of the software configuration; and  
storing the initial configuration of the software configuration in the one or more tables of the CMDB.

14. The method of claim 10, wherein the representation of the GUI includes an indication of active users of the software application, idle users of the software application, or denied users of the software application, or any combination thereof.

15. The method of claim 10, wherein the representation of the GUI includes indications of a number of available licenses for the software application plotted over time, or a usage count of licenses for the software application plotted over time, or both.

16. A non-transitory computer-readable medium comprising computer readable instructions, that when executed by one or more processors, cause the one or more processors to perform operations comprising:

obtaining concurrent license usage statistics for a software application from a license consolidation server by remotely accessing the license consolidation server;  
in response to obtaining the concurrent license usage statistics, updating a software configuration based on the concurrent license usage statistics, wherein the software configuration comprises a license rights allocation for the software application; and  
based on the concurrent license usage statistics and the license rights allocation, generating a representation of a graphical user interface (GUI) that includes an indication of a utilization of the software application.

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17. The non-transitory computer-readable medium of claim 16, wherein obtaining the concurrent license usage statistics for the software application from the license consolidation server comprises executing a remote access call to the license consolidation server, and wherein the remote access call specifies credentials to remotely access the license consolidation server and an identification of the concurrent license usage statistics to be obtained from the license consolidation server.

18. The non-transitory computer-readable medium of claim 16, wherein the operations comprise:

determining an extent of compliance with the license rights allocation based on the concurrent license usage statistics; and

generating a representation of an additional GUI that provides a recommendation to purchase one or more licenses, install the software application on one or more

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devices, or to uninstall the software application from one or more other devices, or a combination thereof, based on the extent of compliance with the license rights allocation.

19. The non-transitory computer-readable medium of claim 18, wherein the operations comprise determining a first financial amount spent on the license rights allocation and a second financial amount of potential financial savings based on the recommendation, and wherein the representation of the additional GUI includes indications of the first financial amount and the second financial amount.

20. The non-transitory computer-readable medium of claim 16, wherein the representation of the GUI includes an indication of active users of the software application, idle users of the software application, or denied users of the software application, or any combination thereof.

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